"Determinants of Limb Length Discrepancy in Total Hip Arthroplasty-A cohort Study in tertiary care hospital"

Thesis submitted to

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH, BELAGAVI.

(Deemed-to-be-University)

[Declared as Deemed-to-be-University u/s3 of the UGC Act, 1956 vide Govt. of India Notification No. F.9-19/2000-U.3 (A)]

(Accredited 'A+' Grade by NAAC) (3rd cycle)

[Placed in Category 'A' by MoE (GoI)]

Doctor of Philosophy In the Faculty of Medicine

By

Dr. Sarang. Shete

(Registration No: KLEU/Ph.D./17-18/D01217003)

Under the Guidance of

Dr. Kiran. S. Patil MBBS, MS Ortho

Professor,

Department of Orthopaedics,

Jawaharlal Nehru Medical College, Belagavi.

2023

UNDERTAKING

I **Dr. Sarang. Shete** hereby declares that the information and the data mentioned in my thesis entitled "**Determinants of Limb Length Discrepancy in Total Hip Arthroplasty-A cohort Study in tertiary care hospital**" belongs to me and is original.

I am aware of definition of plagiarism as detailed below:

- An act or instance of using or closely imitating the language and thoughts of another author without authorization and their presentation of that author's work as one's own, as by not crediting the original author. A piece of writing or other work reflecting such unauthorized use or imitation.
- The deliberate or reckless representation of another's words, thoughts or ideas as one's own without attribution in connection with submission of academic work, whether graded or otherwise.

I hereby declare that the thesis prepared by me is original-one and does not involve plagiarism anywhere. In case at a later stage it is found that I have indulged in plagiarism, then I am solely responsible for the same and the Institution is at liberty to take any disciplinary action against me including cancellation of dissertation or any other penalties imposed by the University.

Dr. Sarang.Shete
Ph.D. Research Scholar
JNMC, KAHER, Belagavi, Karnataka.

Date:
Place: Belagavi

PLAGIARISM REPORT

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Formerly known as KLE University)
(Deemed-to-be-University established u/s 3 of the UGC Act, 1956)
Accredited A+ Grade by NAAC (3rd Cycle) Placed in Category 'A' by MHRD (GoI)
JNMC Campus, Nehru Nagar, Belagavi-590 010, Karnataka State, India
☎: 0831-2444444 Web: http://www.kledeemeduniversity.edu.in E-mail: info@kledeemeduniversity.edu.in

Ref. No. KAHER/AA/23-24/D- 215

8th August 2023

Sir,

The soft copy of Ph.D. research thesis of **Dr. Sarang Shete, Faculty of Medicine, KAHER, Belagavi** has been submitted for anti-plagiarism check at the office of the undersigned through "Turn-it-in" package. The scan has been carried out and the scanned output reveals a match percentage of **5%** which is within the acceptable limit of 10%.

To obtain the comprehensive report of the plagiarism test, research scholar can send a mail to **diracademic@kledeemeduniversity.edu.in** along with the Registration Number, Name of the Scholar, Name of Guide/Co-guide and title of the thesis.

DIRECTOR ACADEMIC AFFAIRS Deemed-to-be University

Dr.(Mrs.) Roopa M. Bellad
Director, Academic Affairs

To,

Dr. Sarang Shete,
Part-Time Ph.D. Scholar,
2017-18 Batch
J.N. Medical College,
Faculty of Medicine, KAHER,
Belagavi.

Cc to :

1. The Principal, J.N. Medical College, KAHER, Belagavi
2. Dr. Kiran Patil, Professor of Orthopedics, J.N. Medical College, Belagavi – Guide

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

(Deemed-to-be-University)

(Declared as Deemed-to-be-University u/s3 of the UGC Act, 1956 vide Govt. of India NotificationNo.F.9-19/2000-U. 3(A))

Accredited 'A^{+}' Grade by NAAC (3rdCycle) Placed in Category 'A' by MOE (GoI)

Copyright Declaration

We hereby declare that **KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH, BELAGAVI, KARNATAKA,** shall have the rights to preserve, use and disseminate this thesis in print or electronic format for academic/research purpose.

Signature

Dr. Sarang. Shete
Ph. D Research Scholar
Registration No: D01217003

Place: Belagavi
Date:

Signature -Guide

Dr. Kiran. S. Patil **MBBS, M S Ortho**
Professor
JNMC KAHER Belagavi
Department of orthopaedics

Place: Belagavi
Date:

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH, BELAGAVI

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

(Deemed-to-be-University)

(DeclaredasDeemed-to-be-Universityu/s3oftheUGCAct,1956videGovt.ofIndiaNotificationNo.F.9-19/2000-U.3(A))

Accredited 'A^{+}' Grade by NAAC (3rdCycle) Placed in Category 'A' by MOE (GoI)

Declaration

I hereby declare that the thesis entitled **"Determinants of Limb length Discrepancy in Total Hip Arthroplasty - A cohort study in tertiary care hospital."** is a bonafide and original research carried out by me under the guidance of **Dr. Kiran. S. Patil,** Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, Belagavi.

The thesis or any part thereof has not formed the basis for the award of any degree/fellowship or similar title to any candidate of any University.

Place: Belagavi
Date:

Signature
Dr. Sarang. Shete
Ph.D Research Scholar
Registration No: D01217003

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

(Deemed-to-be-University)

(Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956 vide Govt. of India Notification No.F.9-19/2000U.3(A))

Accredited 'A^{+}' Grade by NAAC (3rdCycle) Placed in Category 'A' by MOE (GoI)

KLE
EMPOWERING PROFESSIONALS

Certificate

This is to certify that the thesis entitled "**Determinants of Limb length Discrepancy in Total Hip Arthroplasty - A cohort study in tertiary care hospital.**" is a bonafide and genuine research carried out by **Dr. Sarang. Shete** under the guidance of **Dr. Kiran.S.Patil,** Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, Belagavi.

Dr. Niranjana S Mahantashetti
Professor & Principal
KAHER, JNMC, Belagavi

Place: Belagavi
Date:

ACKNOWLEDGEMENT

I would acknowledge every contribution and support that I received for the completion of this thesis work and making this learning experience beautiful and memorable. The completion of this dissertation has been possible due to the patience and guidance of the people around me.

I express deep sense of gratitude to my Research Guide, ***Dr. Kiran.S. Patil****, Professor, Department of Orthopaedics, Jawaharlal Nehru medical College, Belagavi for his excellent guidance, co-operation, timely attention and constant encouragement through-out the study duration. It is his discipline, motivation and positive outlook that helped me grow as an individual and will always be cherished. I shall forever remain indebted to him for having inculcated in me the quest for excellence.*

I would like to extend my gratitude to Registrar ***Dr. M. S. Ganachari, Dr. V.A.Kothiwale****, Ex-Registrar, KLE Academy of Higher Education and Research (KAHER) and a humble thanks to* ***Dr.Roopa Bellad*** *Director of Academic Affairs; and* ***Dr. Daksha Dixit*** *- Former Director of Academic Affairs, KLE Academy of Higher Education and Research for their persistent support and cooperation.*

I express my deep gratitude to ***Dr. N.S Mahantashetti****, Principal, JN medical College, Belagavi, for granting the required facilities and for the kind cooperation throughout. I sincerely thank the Vice-Chancellor* ***Dr Nitin M Gangane,*** *and former Vice Chancellors* ***Prof. Dr. C. K. Kokate & Dr. Vivek Saoji*** *for providing the opportunity to carry out my doctoral study.*

I am thankful to ***Dr. Ravi Jatti****, Professor and Head, Department of Orthopaedics, JN Medical College, Belagavi for his critical assistance.*

I extend my gratitude to my departmental seniors, for their advice and guidance whenever required. I also want to thank my juniors ***Mrs. Dr. Priyanka Charati****, for lending help whenever requested.*

I would like to express deep sense of affection to my dearest friends, ***Dr. Pramod Hurkadle*** *and* ***Dr. Uday Kumar*** *&* ***ex-Dr Tanaji Kale*** *for their constant encouragement and support throughout my dissertation work. Thank you for being a part of my journey.*

I thank ***Dr. N.K Tyagi*** *Ex Head of Department Biostatistics &* ***Dr. Jung B Prasad*** *HOD Biostatistics,* ***Mr .Kiran Prashanth*** *and* ***Miss. Raja Rajeeswari*** *for assisting me with the biostatistics studies, & my friend* ***Dr. Mahendra Chouhan*** *for their kind cooperation throughout this study.*

I would like to appreciate all the support given by the OT & Xray technicians and entire staff of JN Medical College Belagavi, during the entire period of my doctoral work.

I wholeheartedly thank my ***Family*** *including my wife* ***Dr. Hemlata khanapure****, parents* ***Dr. G.S Shete*** *&* *mother* ***Mrs. Shubhangi shete****, my daughter* ***Pratyusha*** *&* *my son* ***Dhruvansh*** *for their immense support throughout my academic career. Without their care, affection and understanding it would not have been possible for me to reach up to this stage. It is to them that I owe my deepest gratitude. And above all my patients whose trust & faith in me have kept my shoulders always high.*

Dr. Sarang Shete.

LIST OF ABBREVIATIONS

AAHKS	:	American Academy of Hip and Knee surgeons
ABD	:	Abduction
ADD	:	Adduction
ASIS	:	Anterior Superior iliac Spine
AVN	:	Avascular necrosis
COC	:	ceramic on ceramic
COP	:	ceramic on polyethylene
CVA	:	Cerebro -vascular Accident
DDH	:	Developmental Dysplasia of Hip
ER	:	External Rotation
ETO	:	Extended Trochanteric Osteotomy
EXT	:	Extension
FFD	:	Fixed flexion deformity
HDT	:	Hypertension-Diabetes-Thyroidism
HHC	:	High Hip Centre
HHS	:	Harris Hip score
HTN	:	Hypertension
Icg	:	Infracotyloid grove
ICF	:	Informed consent form
IR	:	Internal rotation
Intraop	:	Intraoperative
LT	:	Lesser Trochanter
LLD	:	Leg-length Discrepancy /leg length inequality

MOP	:	metal on polyethylene
MOM	:	Metal on Metal
OA	:	Osteoarthritis
OPD	:	Out Patient Department
OT	:	Operation Theatre
PROM	:	Patient reported outcome measures
pre-op	:	Preoperative
PIS	:	Patient information sheet
post-op	:	Postoperative
RA	:	Surface Roughness
ROC	:	Receiver Operating Characteristic Curve
ROM	:	Range of Motion
THA	:	Total Hip Arthroplasty
THR	:	Total Hip Replacement
TSO	:	Trochanteric Slide Osteotomy
Yrs.	:	years

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Determinants of Limb Length Discrepancy in Total Hip Arthroplasty-A Cohort study in tertiary Care Hospital.

Background: Leg-length inequality (LLD) is a common cause of limping after Total Hip Arthroplasty (THA), leading to various issues like patient dissatisfaction, legal disputes, complications, and even the need for revision surgery. Achieving geometrically equal leg lengths in all patients may not always be feasible due to individual anatomical differences and complexities. Balancing stability and function are crucial, and in some cases, prioritizing stability may require sacrificing perfect leg-length equality. There is still a lack of consensus on the clinically significant threshold for LLD, and the perception of LLD decreasing with time after surgery lacks sufficient evidence.

The absence of standardized criteria and assessment methods for LLD makes evaluating intraoperative LLD and stability challenging, as different tests rely on the surgeon's perspective. To ensure successful outcomes, a thorough understanding and measurement of LLD before, during, and after surgery is essential. Restoration of LLD and addressing its variations are vital aspects of THA to optimize patient satisfaction and functional results. Managing expectations and educating both patients and surgeons about the potential issue of leg-length discrepancy post-surgery is crucial for achieving successful outcomes.

Objectives: The objectives of the study were to determine the determinants of (LLD) limb length discrepancy in total hip arthroplasty and identify influential variables affecting the change in LLD from preoperative to postoperative period and to assess

the effect of LLD on functional outcomes using radiographic evaluation, subjective patient reported outcomes and objective clinical assessment.

Materials and Methods: This study is a prospective cohort study with a 6-month follow-up for each patient. It is an interventional study focusing on Total Hip Replacement (THR). The sample size is determined to be 120 patients, calculated based on statistical considerations with allowance for 20 patients' attrition. The outcome variable in the study were Subjective or reported by Patients i.e. PROM-using Harris Hip Scores-HHS[61], Radiological changes before surgery to post surgery on x-rays and Objective clinical Measurements /assessment. Patients above 18 yrs of age and having primary and secondary arthritis of hip were included in the study and data collection was done by pre-op OPD clinical assessment, Pre-op radiological measurements, Intra op measurements & OPD follow up with post-surgery radiological measurement and the tool used for data collection was standard measurement centimeter scale & HHS(Harris Hip Score Questionnaire).

Results: LLD correction(15.54mm) was done intraoperatively and the change in LLD from Pre-operation to post operation is significant with $p<0.001$. The LLD was not varying at different time points(follow ups) post-surgery (f value- 0.0001, *p* value>0.05). The post operative LLD ranged between -14mm to 20mm. Through multinomial regression the determinants of shortening were age, diagnosis, head variation and stem inclination with $p<0.05$ and for lengthening were age, comorbidity and head variation with $p<0.10$. The Regression Model used is Significant with P value <0.001 with 60-77% sensitivity and 67-89% specificity. Post operative LLD had no influence on HHS score and Clinical outcomes (chi sq-0.04 to 6.6, df- 2, P-

value >0.05 and F value -0.1 to 3.6, P-value >0.05) despite of serial improvements in mean HHS scores at follow up intervals.

Conclusion: Age, diagnosis, comorbidity, head size variance, and stem inclination are the factors that determine LLD. According to the study's findings, leg length difference (LLD) between 20mm (lengthening) and -14mm (shortening) is tolerated and has no negative consequences on the outcomes of patients who have undergone total hip arthroplasty (THA). The hypothesis that a certain amount of LLD may be acceptable without compromising functional outcomes is supported by the fact that LLD categories (shortening, restored, and lengthened) did not significantly effect changes in ROM and HHS scores.

Keywords: Hip, Arthroplasty, LLD, Leg length inequality, Patient Reported Outcome Measures,Replacement,Arthritis,X-Rays,Endoprosthesis,osteonecrosis.

1. INTRODUCTION

1.1 Background

Hip surgery is an established science & skill in the 21st century, but a century ago scope of complications were so different that contemporary hip surgeons will never forget about an era, which existed before the technological advances, in which even the most aggressive surgeons were reluctant to endeavour on the hip surgeries. [1]

Whereas various hip operations and sub types exist, arthroplasty is unique & considered a routine norm in today's surgical practice, this is owing to its global acceptance & time- tested success. [2, 3, 4]

Total Hip Arthroplasty (THA)[5, 6]: It is a surgical treatment that entails the removal of unhealthy joint surfaces on the acetabular side along with femoral head of an arthritic hip (coxarthrosis) and the placement of artificial prosthesis (implants).

Arthro (Gr) = joints, Plasty (Gr)= surgical repair, while arthritis [5,7] is a disorder of joints.

THA classification is of numerous ways, it could be as per implanted materials 8, 9, or surgical approach used like posterior/anterior/lateral or as per staging (single stage or in two stages e.g.: primary THA (first time surgery) or revision THA of a previously done THA. Types are also as per articulating materials utilised[10]

1. MOP-metal on polyethylene
2. COP-ceramic on polyethylene
3. COC-ceramic on ceramic or
4. MOM-metal on metal

Similarly, classification is based on the way the implants are anchored to host bone.

A. Hybrid method: - Uncemented cup with a stem that is cemented.
B. Reverse hybrid: - with an uncemented stem and a cemented cup.
C. Uncemented - The prosthesis is a press-fit concept, and implants are typically coated with Specially invented material in specific $(RA)^6$ surface roughness and optimum pore size of 100 to 400 um or coatings like HA-hydroxyapatite, FMT-fibre mesh taper, or porous, depending on the way the metallic integration is supposedly going to take place between bone and these surfaces termed as in-growth or on-growth fundamentals of integration.
D. Cemented - Bone cement is used to fix the highly polished metallic stem of the femur and the polyethylene shell of the acetabulum.

This endoprosthesis replacement of an arthritic hip is to relieve the pain of the patient.

The primary goal of THA is to reestablish the biomechanics of the hip joint[6,7,10,11]. The biomechanical re-establishment involves:

- Hip stabilisation with restoration of femoral offsets (horizontal & vertical)
- Achieving correct centre of rotation,
- Precise placements of implants, and
- Ensuring correct length of both limbs so as to gain optimum functional outcome post THA.

THA is much like any elective surgery & not free of its complications. The THA complications are categorized as per their occurrences like late occurrences after the surgery or if they arise directly owing to surgical procedures whether during the

surgery [12] or immediately in acute or delayed post operative periods[6,7,13]. Among various complications concerned with total hip arthroplasty, limb length discrepancy or LLD is a unique complication as it exists preoperatively, is changed & gets altered during intraoperative surgical procedure and manifests postoperatively.

LLD related to coxarthrosis can result in a variety of disabilities, such as poor gait, pain in lower back, obliquity of lumbosacral & pelvic region, and necessity to use shoe raises. Social issues are also shown by 20 mm to 30 mms of LLD happened, even before surgical interventions.[5,7,14,15].

Other relevant post operative complication along with limb length discrepancy, are complications related to abductor muscles, trochanteric bursitis, periprosthetic joints infections or delayed complications like heterotopic bone formation & osteolysis. [6, 16, 17]

LLD is the second most common source of malpractice[18] litigation after nerve injury in THA, this was according to a survey of AAHKS-American Academy of Hip and Knee surgeons[6]. LLD in THA depends on surgical procedure and implanted prosthetic material.

Fig A1: THA Implants (Prosthetic material)

After the surgery of THA, if patient comes with any of the consequences of LLD, determining if there is an true/apparent LLD is the 1st thing to do.Thus,for any treatment one needs to classify LLD, these types of LLD are :[19,20]

- True or Type 1 /structural
- Apparent or Type 2 /functional

As per some authors LLD with structural patterns did have the functional component in most of the patients 64% (i.e., associated functional element of LLD). Hence elimination of this Type 2 LLD is highly considered before initiation of concrete treatment for Type 1 or True type of LLD [21, 22, 23, 24] .

A proper Xray assessment will enlighten on the type of LLD suffered by the patient[24,25]

LLD of Functional category: Bony structures and implants are restored but cause of difference in any unilateral change in LLD is owing to postural change occurring by contractures in the soft tissues or pelvic obliquity. [25,26, 27]

LLD of structural category: Responsible cause is anatomical difference in bony lengths and already used prostheses and can be subdivided as:

Primary: - LLD directly related to position of implants(Component Malpositioning.)

Secondary:- As implant mispositioning along with accompanying inequality of legs.

Besides this, some authors classify it into mild /moderate & severe forms. Most severe form of LLD are seen in the patients with DDH[28] (Developmental dysplasia of hip) Most of the surgical interventions in the form of THA in such patients, in particular to Type 3 & Type 4 Crowe classification, utilizes compromising the anatomic hip centre to HHC-high hip centres, yet giving good clinical results & optimal survivourships.[29] Some surgeons have restored LLD with subtrochanteric osteotomy & other more anatomical hip centring in severe grade & neglected hip dysplasia. But this form of arthritis is more prevalent in countries other than Indian sub subcontinents, its occurrence may change with changing lifestyle & more urbanisation in India also.

Very rarely repeat surgery of a THA (revision) is undertaken in case non-operative treatments of LLD fails.[6,19]

Regarding its prevalence 30% of non-arthritic healthy individuals also have LLD & that also may range till 2cm, but this is not noticed as most commonly it gets adapted by spinopelvic & other mechanisms & its perception is ceased or does not exist.

In Indian scenario LLD & its prospective studies are few, as probably, majority of individuals who experience LLD during the initial stages of their recovery from surgery do so because of a functional discrepancy that becomes better with time and with physical therapy. However, a small percentage of patients, primarily those with severe LLD, or even the unsevere ones who remain dissatisfied with the hip after an arthroplasty procedure, need to be paid attention.

It is noteworthy with increasing number of THAs or 14 reported LLD litigations as in Patterson et. al. & Pai et. al's literature review on orthopaedics litigations in Indian scenario, it's crucial to identify patients who are susceptible to LLD & know its broader influencing factors if one has to stop this issue.[30, 31, 32, 33]

1.2. REVIEW OF LITERATURE

In the review article by **I D Learmonth, et al** titled "THR as the operation of the century. from the journal Lancet 2007, Authors emphasizes usefulness & success of Total Hip Surgery since 60s & credits Dr. John Charnley of Wrightington UK, for transforming the field of Arthroplasty and establishing the principles of biomechanics of Total Hip Arthroplasty (THA) including success story of modern day cemented THA & Charnley's famous concept of Low Friction Arthroplasty .[2, 5]

In the book The Adult Hip vol.1. 3rd edition. Wolter Kluwer. **2016 J J.Callaghan, A Rosenberg, J. Della Valle Et al** has illustrated thorough history of THA & given over view with in depth information related to THA & the current scenario on the topic of LLD.[6]

As per **A Malviya, N Abdul, Vikas Khanduja et al. 2017** [7] in the Indian journal of orthopaedics as per article of outcome after total hip replacement -and its study about registry data, authors have described the results of numerous registries, suggesting inputs about cups & methods of fixation, articulating surfaces, and sizes of femoral heads to be considered during THR operations & how these suggestions are backed by the current available registry data. Each countries Registry gives us volume of joint replacements done in a particular area, region, or a nation depending on contribution done by the surgeons. Most importantly it explains the changing trends or current scenario of used implants in the patients and other relevant alarming information like deleterious effects of metal-on-metal implants seen in metallosis lesions of hip replaced patients. This can be derived through years of accumulated data of these individual registries.

In the 56th annual meeting regarding international survey about total hip replacement surgeries (both revisions & primary) by orthopaedics research society which was conducted in the year **2010**.[11] in which authors **Kurtz SM, Roder C, Lau E, et al** have emphasized the primary goal of THA as to reestablish the biomechanics of hip joint. As such registry data does not specifically highlights LLD in THA as complication.[11]

In the year of **2016** the 13th Annual report was presented by British, Irish & surgeons from Isle of Man, regarding registry data of arthroplasty operations, Thes regions have their own joint combined registry**:** Which has the specific objective of spreading information to surgeons the data of 83000 Hips in their region showed 73% of implant survival at 35 years, which also explains & confirms the utility of THA over long term period.[34, 35]

In the book **Chapman's Orthopaedic Surgery, 3rd ed** [10] types of Total Hip arthroplasty have been mentioned as per bearing surfaces into Hard on hard for metal on metal-MOM & ceramic on ceramic COC bearing surfaces, while Hard on soft for MOP-Metal on poly & ceramic on polyethylene –COP bearing articulations used in Total hip arthroplasty.

In further classification of types of arthroplasties, joint replacement institute classifies THA into cemented and un cemented **types** and elaborates various methods-of-fixation**.2018** [36]

In the book Hip Arthroplasty Surgery, vol.first. about adult hips in 3rd ed. **2016** [6]**John C. Clohisy, Beaule Et al** in chapter 84, has mention LLD as a complication which can cause pain and dissatisfaction in the patients.

As per the article: revision surgery for leg length inequality after primary hip replacement published in hip international 2018 the authors **Anthony B Mc Williams et al** [37] has mentioned requirement of revision surgery for LLD after primary hip replacement in patients having unresolving pain and do not respond to conservative management for a period of 3-6 months. In this study it has been further emphasized results of 95% patients being satisfied after revision surgery for specific cause of LLD in 20 out of 21 patients.

In the book the adult hip, vol:2, Leg length inequality, **Edeen J, Sharkey PF, Alexander AH[38]et al.** Clinical importance of LLD in total hip joint replacements. They followed their patients from 2 to 20.5 years with average of six and half years,

They showed in the study overall average of LLD as1.49 cm, but patients who were aware of such difference had mean inequality of less than 0.97 cm in 32% patients. remaining half of the patients (50%) were disturbed by this LLD. The degree of leg-length discrepancy, aberrant gait, usage of ambulatory assistive devices, the requirement for a correcting the height of shoes, previous leg-length inequality, and revision THA, according to the authors, patients were highly connected with the inequality's extent. The author's secondary goal was to identify the clinical effects of this leg-length discrepancy, including patient satisfaction, gait problems, etc.

It is understood that LLD effects the gait and biomechanics as told in study by **McCaw et. al.**[39], the findings are suggestive that mild leg length inequality(3cm) can have significant biomechanical implications on gait. Individuals with LLD may exhibit compensatory changes in their gait mechanics to adapt to the leg length difference. These adaptations could affect stability and potentially lead to gait asymmetries.

In a study by **White TO, Dougall TW et al[40]**. Arthroplasty of the hip. Leg length is not important from JBJS **2002**. The author had objective to study the correlation between LLD and functional outcome.in 220 patients. In this study despite of having series of more than 200 patients no statistical correlation was found but 71.5 % patients had LLD with in 10mm (-11 to +3).

To ascertain how LLD affects gait in relation to physiological parameters in 44 old adults. **Gurney B1, Mermier C, Robergs R, Gibson A, Rivero D.et al 2001[41]**. In their article of affect of LLD on gait in adults and lower extremity muscle activity in old adults concluded that there is a break point between 2 cm and 3 cms on physiological parameters (oxygen consumption and rating of perceived exertion) thus they concluded that LLD of even 2cms greatly affect the walking capacity of elderly patients with multiple comorbidities.

For a review article about measurement of offset its function and influence on femoral side offset and details of influence of Anteversion on offset. By **Flecher M. Ollivier J. N. Argenson et al. 2016**[42] had concluded as careful consideration of the prosthetic hip's 3D geometry is essential for both limb fun ction and implant survival. The author also states that maintaining or restoring limb length necessitates a careful examination of all the elements that are present inside or beyond that of the hip joint. It has more emphasis on CT. This research study, was published as: Lower limb length and offset in total hip arthroplasty

In their article by authors **A. Konyves, G. C. Bannister al[43] 2005;** mention the need and importance for restoration of LLD as it is assumed in orthopaedics' that there will be improvement in patients LLD with the time gone, this perception in regard to LLD is not true & should not be taken as truth. They further state that

definition of LLD and its measurement methods has lot of differences from surgeon to surgeon & in literature also. Standardisation of Methods is needed. Moreover, there is no single test or accurate method to assess LLD on table along with stability. They feel operating surgeon's perception has influenced these techniques of intraoperative measurements.

In the paper Cementless Total Hip Arthroplasty in Crowe 3 & 4 Dysplasia: High Hip Centre & Modular Necks. Authors **Maurizio Montalti, Francesco Castagnini, Aldo Toni et al[44]2018** mention feasibility of non-anatomic cup positioning in HHC high hip

Centre with slight medialisation as a valid technique in DDH patients, they also mention importance of modular necks, its usefulness for restoring LLD in THA, particularly in Crowe type 3 & 4 types DDH patients. This study had 80 patients at final follow up & results in the form of Clinical scores were good with overall survivorship of 90.5% at 15 years follow up.

In the article by Authors **Rakesh Gupta,Raj Singh,Majumdar et al 2019 [45]** The authors of this study introduced the stitch technique as a straightforward and successful approach for reducing limb length difference after total hip joint arthroplasty. They found that the mean radiological LLD calculated before surgery as minus 9.84 mm. this changed to plus 2.72 mm (in average of from -5 to +6 mm). As their findings were comparable to result of mean of Dr Ranawats study, authors concluded on the effectivity of double stitches techniques used intraoperatively. But They have opinion in the discussion as Ranawats Steinmann Pin method to be an invasive technique than theirs. Which they had studied along with the adjusted Callipers Technique of another author study by **Jasty M1, Webster W, Harris W. et.**

al,[46] 1996 for the management of LLD. As such, in The Ranawats Pin technique,is just placed in already opened surgical wound at icg or infracotyloid grove or tear drop level & never inserted in the bone to be called as invasive. Nevertheless, other calliper techniques are invasive & like double stitch technique need insertion outside the surgical field intended for Total hip surgery.

In the article by authors **Ismail Hadisoebroto Dilogo, MuhTrinugroho Fahrudhin, Anissa FebyCanintika et al 2019 [47]** from the research paper titled "How is the outcome of primary difficult total hip arthroplasty? A cross-sectional study" the follow up is 6 months duration for 81 primary hips over 5 year period. The authors have divided groups into difficult & simple as per bone defects ,fused hip &LLD>5cmand presented flow chart for primary difficult group 29 hips & primary simple group of 52 THR pts.

In the study by authors **Hiroaki Tagomori, NobuhiroKaku, Tomonori Tabata, Hiroshi Tsumura et al. 2020 [48]** titled "A new and simple intraoperative method for correction of leg-length discrepancy in total hip arthroplasty." The authors describe a similar intraoperative method like Ranawats stein mein pin to measure LLD.This study was a level 3 evidence prospective study of one year follow up of 105 patients. Using Acetabular rear wall as its bony landmark (as against icg in Ranawats study) & it had hips operated by using only posterolateral approach. Authors further mentions Limitations of this study include the lack of a control group in which this method was not used, and the lack of head-to-head comparisons with other methods. Besides this study used CT based preoperative assessment which causes radiation to all patients this aspect also need to be compared to studies involving just X Rays which has significantly low radiations.

In the webpage on the website of "International centre for limb lengthening" definition of LLD start with basic 3 types[49] (a) congenital (from birth) (b) developmental (during childhood injuries affecting growth area of physis c) posttraumatic (owing to fracture). Here the treatment modalities and definition itself is always in relation to paediatric patients and rarely concerned with adult LLD. To make it precise rarely an arthroplasty surgery in the form of THR: Total hip Replacement is done in children, but the point of relevance is definition of LLD per se if understood has to be understood in separate manner for adult & for children despite both being termed as LLD.

In the article by authors **Upadhyay A, York S, Macaulay W, et al. 2007** [18] titled "Medical malpractice in hip and knee arthroplasty." Regarding nature of adverse events, it is mentioned that 7.9% (49 respondents) were defendants in litigations for US hip Surgeons in the AAHKS. The first common cause was nerve injury followed by LLD then infection then vascular injury then hip dislocation.

In the article by authors **Shiramizu K, Naito M, Shitama T, et al. . JBJS Br. 2004** [13] about "L- shaped caliper used in LLD measurements intraoperatively." In this particular study of 100 hips the author claims accuracy in predicting the changes in limb length in the surgery. This significance was credited by the author for L shaped caliper ($p < 0.0001$, $r = 0.934$). Even though he accepts in the discussion part that, ocassionally it was not possible for the surgeon to observe the hip joint position accurately and help of by standing staff was taken. This exact position and difficulty in assessing such important measurements were not clarified. The authors suggestion of need for assessment of intraoperative limb length measurements, especially for patients with marked preoperative inequality is well quoted, yet precise numbers of

this marked preoperative inequality in cms or mms for affected patients were not given rather affected diseases like primary and secondary osteoarthritis, rheumatoid arthritis or avascular necrosis were mentioned in 2 groups.

In the article by authors **Dimitros Vasileious Papadopoulos, Panagiotis Koulouvaris, et al**. **Indian J Orthop. 2017** [50] about Intraoperative measurement for LLD with skin sutured technique derived statistical correlations in the means from before & after surgery LLDs. In view of their limitations the author accepts that the method of exact reproduction of position of leg at the time of measurements is not possible and such differences related to the position of leg while taking measurements will affect the results. Also, the skin technique has a disadvantage of three dimensional error as the distance measured is between one bony land mark of lateral trochanteric area and one skin mark of lateral side of pelvis attached with a suture as this is not an error free method in obese patient.

In the retrospective study by authors **Yin-qiao Du, Jing-yang Sun, Hai-yang Ma, Sen Wang, Ming Ni, et al**. **June 2020** [51] titled "Length Balance in Total Hip Arthroplasty for Patients with Unilateral Crowe Type IV Developmental Dysplasia of the Hip." Done over a period of 7 yrs in 60 patients, definition of new non LLD group(<10mm) was described. The author has also described length of the lower limb= leg length. This leg length is measured from tear drop to mid-point of ankle joint. This was compared on operated and non-operated sides on a long film xray as shown below.

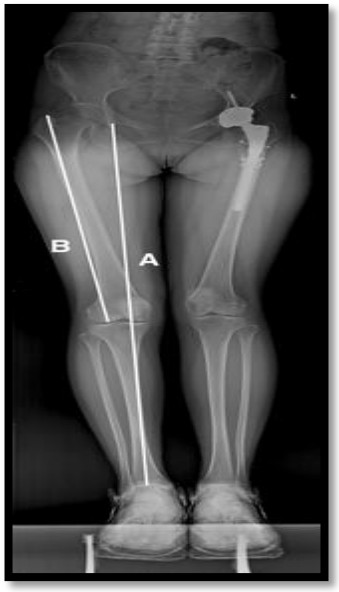


Fig A2: HKA view

In the article by authors **Moslemi A, Kierszbaum E, Descamps J, et al Dec 2021** [52] studied e anterior approach (DAA) on a routine OT table and another group studied for LLD using traction assisted table . Authors had an study objective about effect of operating tables & leg lengths when hip was operated by either of the approaches, but could not establish statistically sound correlations & concluded as no difference in LLD for anterior approaches THR regardless of the used OT table traction assisted or regular standard table.

In the article by authors **Mo TT, Zhu YS, Zhang JN, Zhang WK, Jiang C** of sept **2022** [53] Authors succeeded in concluding that osteotomy of the Trochanteric Slide pattern(TSO) added with a conical designed stem without utilising cement as an valid option in arthritic type 4 congenetically affected dysplastic hips having severe forms of LLD along with dislocations.

In the article of July 2021 by **Ma JM, Lu HL et. al.**[54] "effect of proximal femur morphology on LLD after total joint arthroplasty of hip" In this study, the authors aimed to explore the effect of various shapes of the proximal femur on (LLD)

following total hip joint arthroplasty. They derived an index for proximal femur anatomy termed as FCI, this FCI had direct relation about risks for lengthening & shortening observed in patients undergoing surgeries. As per the authors Their study also has the potential to predict this change in leg length if the shapes of femora's are studied prior to THAs.

In the article of Dec 2022 by authors **R.E. López , J.M. Pelayo de Tomás , Rodrigo Pérez et. al.** [55] **[**Translated article] studied superiority & inferiority of monoblock design implants and with implants having modularity in THA ,so as to have predictable association with LLD in either of the implants types. Their study could not find clear association to prove this

In the article of Dec 2022 by **Hardwick-Morris M et. al.**[56] **,** authors found LLD difference of more than 1cm between two categories with strong association in their so called EOS system of measurements, along with functional limb difference measurement and true lengths measured till ankle. Their study was named as whether pelvis measurements are enough for LLD.

In the study by **Hirano et al. 2023 (Sci Rep)**[57] about relation of femoral offset and THA outcomes. Authors mention the utility of global femoral offset studied by them. In a study by **Ross Doehrmann DO et al/ 2023**[58] in the article about using a Fluoroscopic Grid to Measure Limb Length and Offset Accurately in an Anterior surgical Approach authors emphasises how he used this grid in 145 patients' method which is cheaper than digital software.

In a study in **2023** by author **Ghee Wala**[59] in a Review article has suggested how to do templating of hips preoperatively to avoid LLD and what could be the

better strategies needed to reduce effect or chances of LLD before during & after the surgery, they have suggestions for operative & conservative management of LLD.

Similarly, importance of preoperative templating to avoid LLD of hips in THA has been extensively explained in the chapter Arthroplasty surgery by authors **Samar k Biswas, Sarang shete et. al./2020** [60] in the book Orthopaedics -A Postgraduate Companion.

1.3 JUSTIFICATION FOR THE STUDY

Current orthopaedic literature does not have universal common definition or global consensus for the terminology of LLD. LLD is also called as limb length inequality or hip length difference by some authors. In clinical orthopaedics apparent & true limb lengths are measured to anticipate extraarticular & intraarticular causes of hip deformities & this is confirmed radiologically before the execution of surgeries. Thus, even though x-rays help in understanding presence of LLD in a hip preoperatively, measuring it preoperatively & intraoperatively with a practically easy yet reliable method for restoring the joint stability without excessive increase or decrease in length difference is an essential part of Total Hip Arthroplasty surgery. Besides this range of acceptable & nonacceptable LLD in THA has large variability in literature, as such, for orthopaedic surgeons knowing the determinants which can put the patients at risk of LLD is not only important but essential.

RESEARCH HYPOTHESIS:

H1: (Research hypothesis) LLD has effect on outcome of THR.

H0 : LLD has no effect on outcome of THR

2. OBJECTIVES

PRIMARY OBJECTIVES

- To determine the determinants of (LLD) limb length discrepancy in total hip arthroplasty and identify influential variables affecting the change in LLD from preoperative to postoperative period.
- To assess the effect of LLD on functional outcomes using radiographic evaluation, subjective patient reported outcomes and objective clinical assessment.

SECONDARY OBJECTIVES

- To assess change in LLD is associated with measurable patient intolerance for follow up period of 6 months.
- To establish the threshold at which LLD becomes clinically significant.

3. MATERIALS & METHODS

STUDY DESIGN: A cohort study with each patient being followed up for 6 months in a prospective study design.

STUDY SITE: KLE society's Dr Prabhakar Kore Hospital & Medical Research Centre and at Department of Orthopaedics in the Belagavi City.

SELECTION OF SUBJECTS:

INCLUSION CRITERIA

- Patient with primary and secondary arthritis of hip.
- Age: above 18 years old patients with hip Arthritis.
- Ex: Juvenile Rheumatoid Arthritis to primary & Secondary Osteoarthritis

EXCLUSION CRITERIA

- Patients of recent or ongoing infections of hip (example: arthritis or sepsis or osteomyelitis)
- Patients having cardiac or lung compromise or deemed unfit by anesthesiology department.

- **TYPE OF STUDY:** Interventional study of THA patients
- **INTERVENTION:** Total Hip Replacement/THA-Total Hip Arthroplasty
- **SAMPLE SIZE:**120 (as per 1.96^2*1.2/0.04) (includes 20 patients for attrition)
- **STUDY DURATION**: Two years

SOP FOR MEASUREMENTS:

1. Clinical measurements:

Distance from anterior superior iliac spine or ASIS to ankle at inner side of medial malleolus for limb length in both the lower limbs in centimetres, using a standard measuring tape.

2. Radiological measurements:

Measurements as on computerised digital images were taken on x-rays for change in LLD- thus having an estimation of true LLD.

Method: Distance from inter ischial line or inter tear drop line to LT (ie; lesser trochanter) was measured on preop x-ray & post op X-rays. These X-rays were repeated at 14 days then one & half months, later at 12 weeks, at 90 days, at 6 months & were documented.

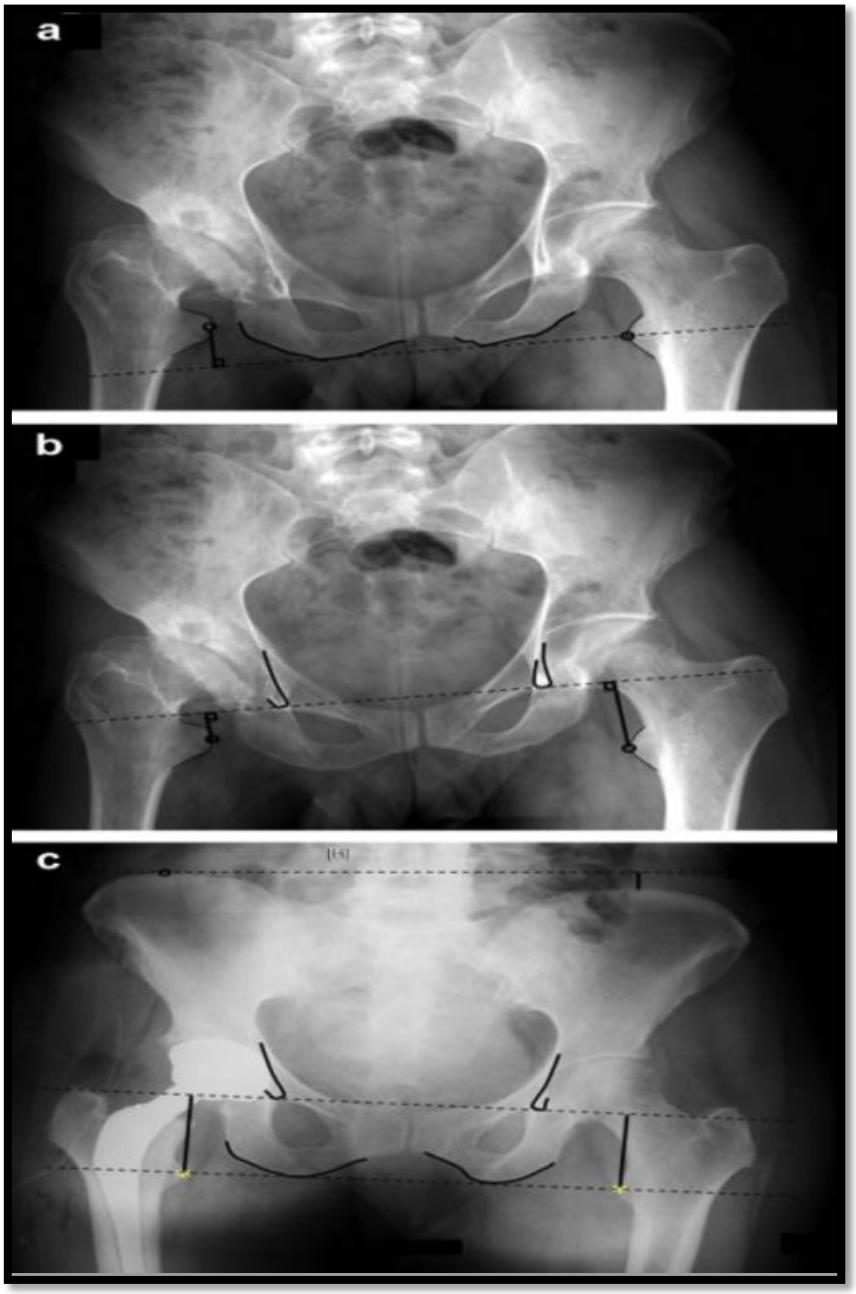


Figure B: (a-Preop Inter-ischial line/b-Inter Tear drop line /c-distance from LT to tear drop

3. Intra-operative measurements

This involved measurements during surgical procedure i;e intraoperatively & from implant sizes.

1. Surgical procedures:

Measurements of level of neck cut & distance of Kohlers line from Cup & Proximal femoral osteotomy (level of femoral neck cut measured intra-op and on x-rays). Depth-size of acetabular(cup) reaming from TAL-transverse acetabular ligament.

- Ranawat's method of stienmein pin by marking icg-infracotyloid groove was used to measure intraoperative change in length[6] once the hip was approached, before hip dislocation (prior to neck osteotomy) and after the final implantation & final reduction of hip.

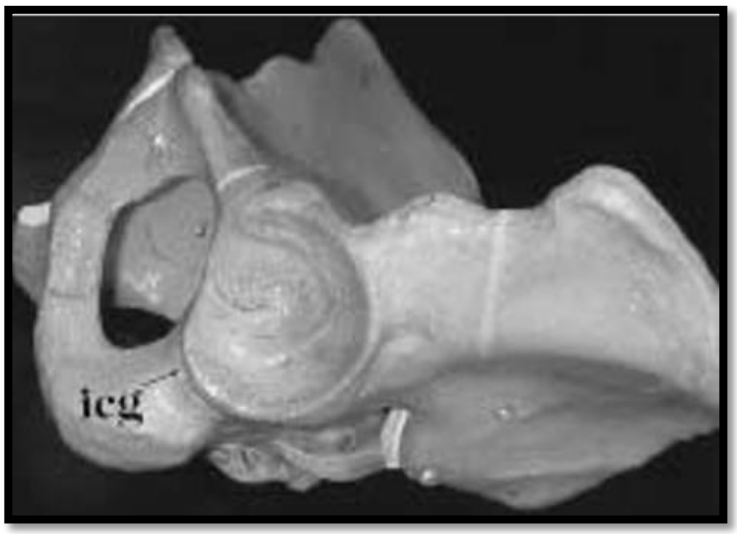


Figure C-Icg-infracotyloid grove

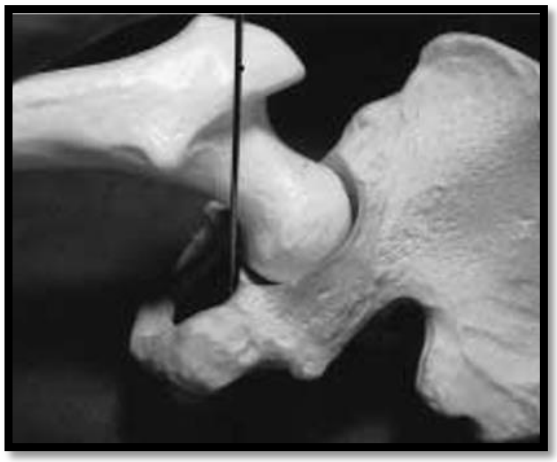


Figure D: Ranawats method of stienmein pin

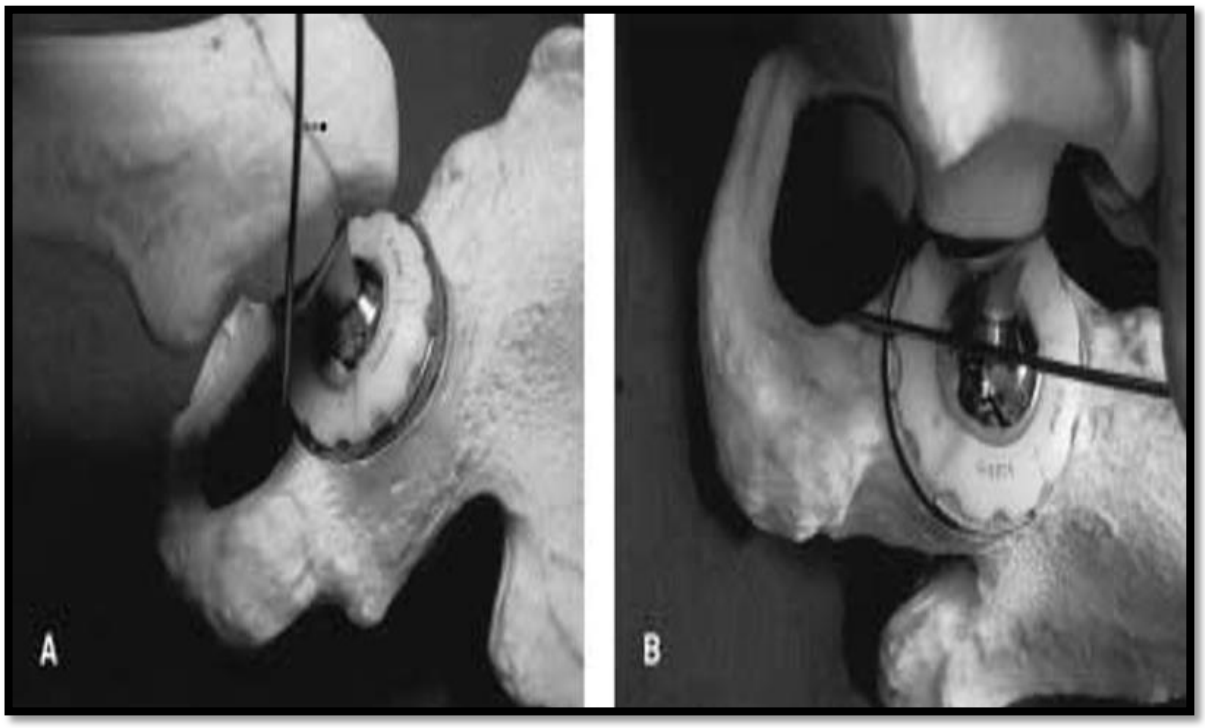


Figure E: After prosthetic implantation (B)/ pin at icg & difference in LLD at GT mark (A)

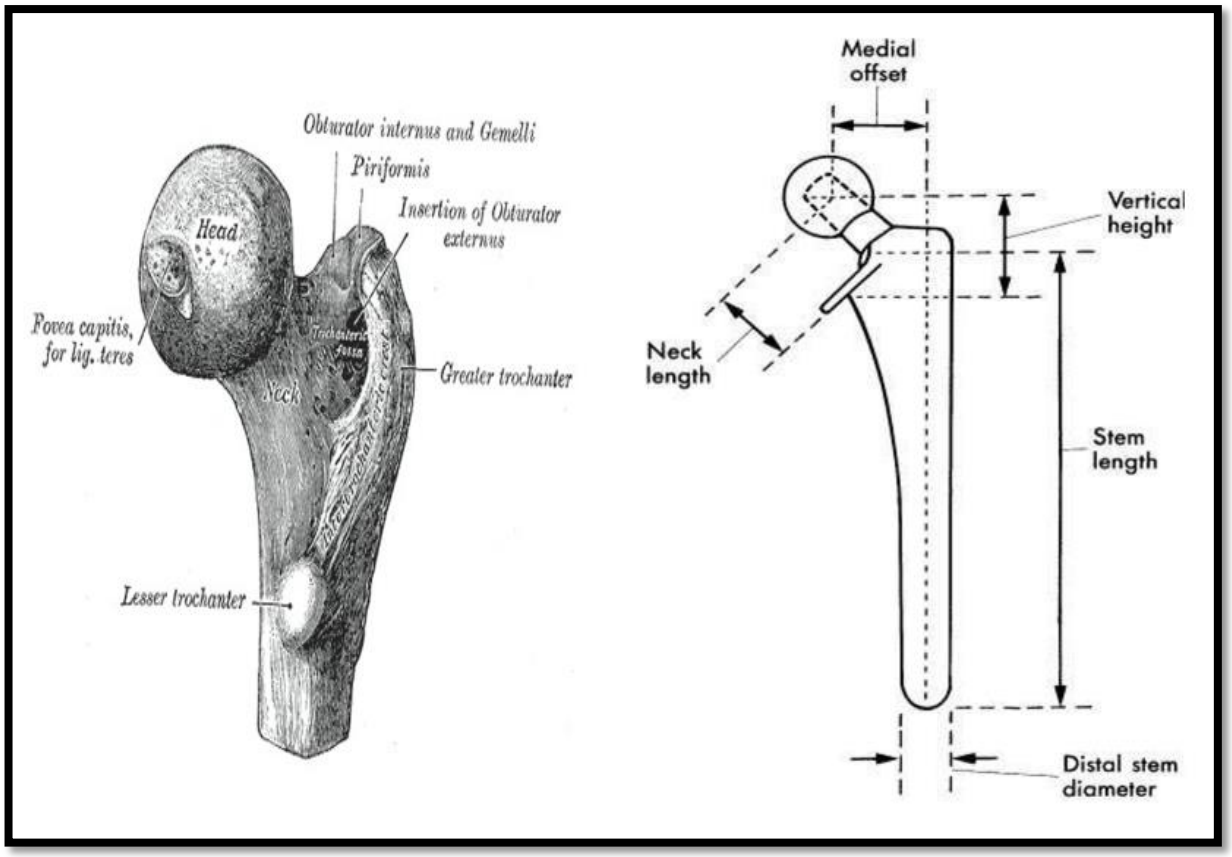


Figure F: Basic design of Femoral component/femoral stem similar to original femur

2. Implant variables:

Acetabular cup/liner thickness/femoral head size/offset/neck length, femoral component size, distance of femoral component from tear drop & infracotyloid groove was documented as per the standard stickers available from manufacturers.

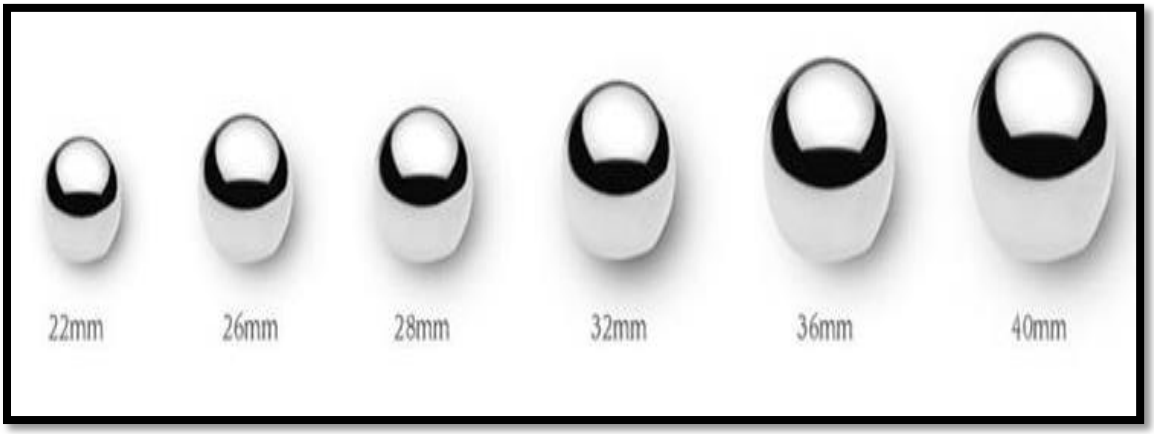


Figure G: Femoral head sizes

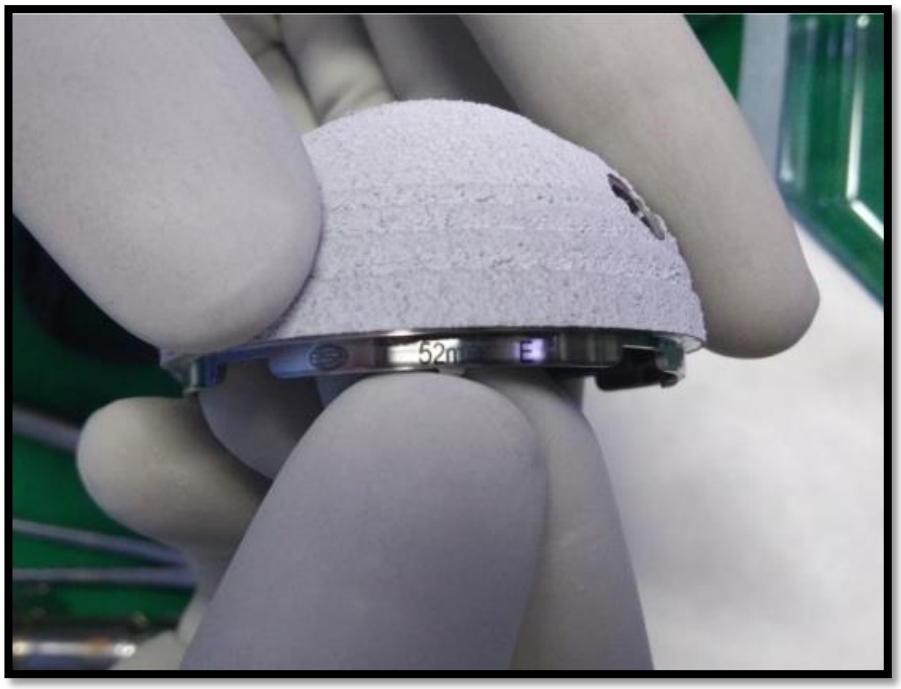


Figure H: 52 mm cup Available by company stickers and on implant also

TOOL FOR DATA COLLECTION:

Materials:

1) Informed Consent Forms: including Hospital admission consent form & surgery consent forms & Anaesthesia consent forms were taken.
2) PIS-patient information sheet as in Annexure B were taken
3) Patient name age sex diagnosis /comorbidities & other details were noted.
4) Questionnaires for the Patients through HHS (Harris Hip Score Questionnaire) were filled as in Annexure C.
5) Standard measurement centimeter scale was used for clinical limb lengths.
6) Xray measurements were taken on standard digital x-rays.
7) Intraoperative by steinmein Pin Ranawats method for LLD was taken.
8) Master chart for data accumulation was prepared & documented.

METHOD OF DATA COLLECTION:

- pre-op OPD clinical assessment,
- Pre-op radiological measurements,
- Intra op measurements & OPD follow up with post-surgery radiological

Measurements along with HHS documentation.

STATISTICAL ANALYSIS:

Data was computed & analyzed by various statistical methods: ANOVAs, correlation and regression analysis. Master chart was prepared / filled at each visit of post operative 14th day again on 6th week, later at 3rd month & 6 months for each Patient.

Statistical test: Statistical methods like chi square and other methods appropriate were used to analyse the data generated from the study.

Study outcomes measures:

Primary outcomes: Precise Change in LLD from

1) Preoperative clinical to postoperative clinical follow up of 6 months.
2) Preoperative radiological measurements to post operative change on x-ray measurements.
3) Intraoperative change in limb length by using Ranawats Technique of steinmein pin measurement.

Secondary outcomes: Functional outcome using following pattern was deduced & analyzed.

OUTCOME VARIABLES (A + B + C)

A**: Subjective** or Patient reported by patient reported outcome measures PROM-using Various hip scores-HHS (Haris Hip score) [61]

B**: Radiological** changes from pre surgery to post surgery on Xrays.

C: **Objective** clinical Measurements /assessment

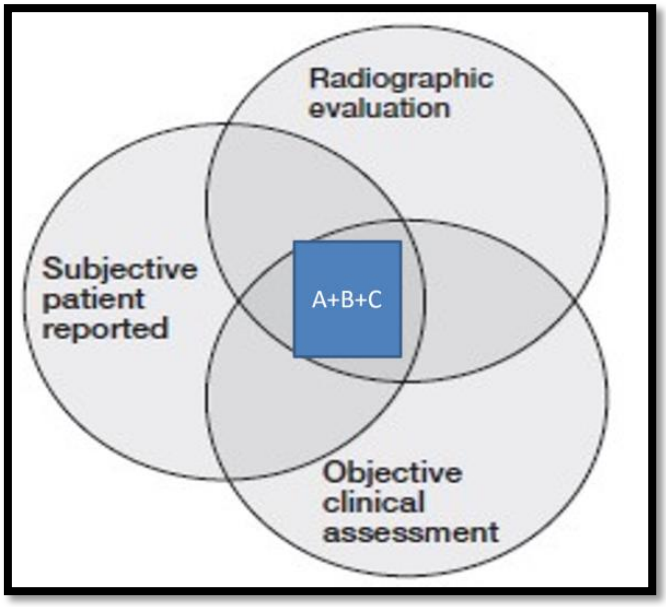


Figure I: Functional outcome (A+B+C)

Participant selection and recruitment:

Informed consent: Informed consent form (ICF)/ Participant information sheet (PIS-**Annexure B)** in English or in other patient preferred local languages like Kannada, Marathi were provided for the eligible patients. The patient was given brief information regarding the study, its goal, the advantages and hazards of participating, the length of the research, monitoring, confidentiality, and the participants' rights to withdraw from the study. Questions and concerns about the study were answered. Two copies about information & consent as patient information sheet -PIS(Annexure B) were signed by the patient once the patient consented to take part in the surgery & LLD research. Out of which one was given to the patient for reference and one was taken by the investigator for documentation.

3. Data Analysis

Statistical methods like chi square and other methods appropriate were used to analyse the data generated from the study.

Statistical analysis was done by using IBM SPSS Statistics version 20 & Microsoft Excel Worksheet software.

Descriptive statistical analysis was performed for deriving Mean/median/interquartile range/range, percentage, percentile. Graphical representation was done using Bar graphs /histograms & line charts Test statistics: To study determinants, bivariate & multinominal logistic regression models were applied. Association was studied using chi square.Comparisons were studied using t-test & ANOVA.

4. RESULTS

Demographic Distributions

Figure 1. Age wise distribution of patients

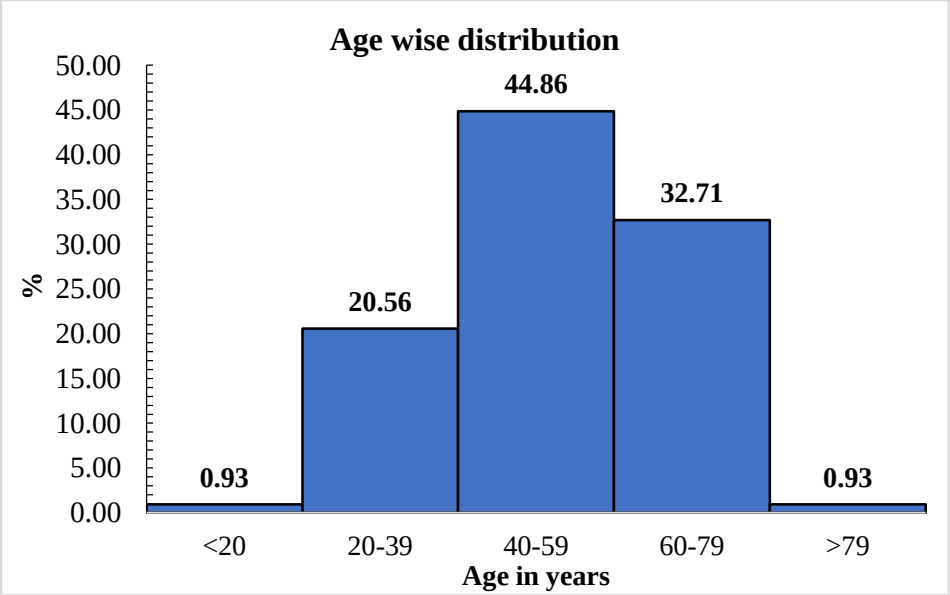
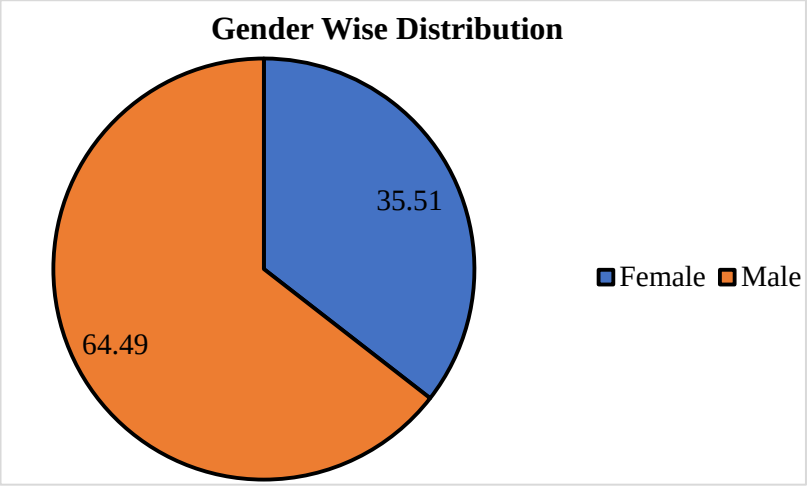


Table 1: Age wise distribution of patients

Age Groups	n	%	Mean	SD
<20	1	0.93	52.52	15.38
20-39	22	20.56		
40-59	48	44.86		
60-79	35	32.71		
>79	1	0.93		
Grand Total	107	100		

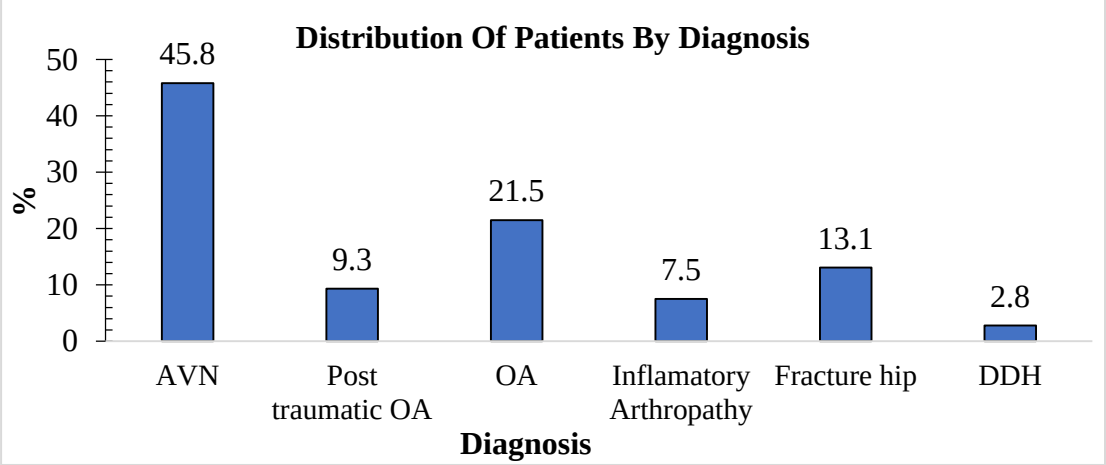
The age wise distribution of patients in study shows that patients were between age of 18 year to 81 years. The mean age was 52.5 yrs. with standard deviation of 15.4. Maximum patients (44.8%) were from 40-59 age group and only 0.9% in less than 20 and more than 79 yrs. age.

Figure 2: **Gender wise distribution of patients in year 2018-22**



The gender wise distribution of patients shows that females and males were 35.5% (38) and 64.5% (69) respectively.

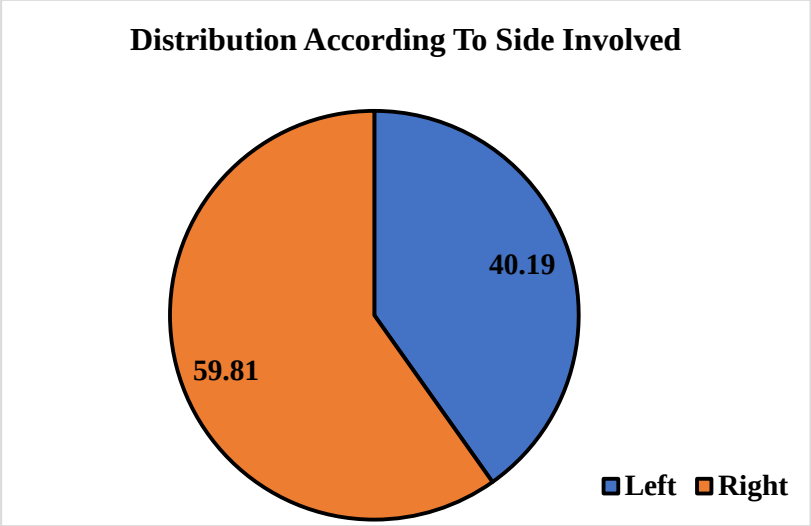
Figure 3: **Diagnosis wise distribution of patients, in year 2018-22**



Note: OA – Osteoarthritis, AVN- Avascular necrosis, DDH – Dysplastic hip

Patients who underwent THA were divided into 6 categories of arthritis aetiology wise. Among these 45.8 % (49) had AVN, next leading cause was OA with proportion of 21.5 % (23). 9.3% (10) were Post traumatic OA and patients having recent fracture of hip was noted in 13.1% (14), and inflammatory arthropathy was diagnosed in 7.5% (8), while DDH was noted in just 2.8 % (3) of the study subjects.

Figure 4: Involved Side wise Distribution of patients



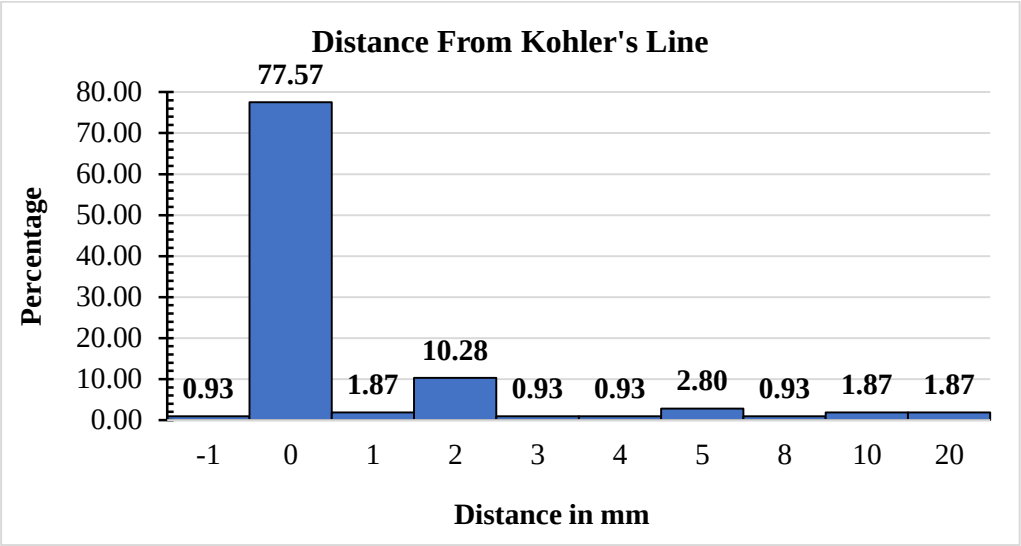
Distribution based on side involved showed that in 40.19% left hip was involved and 59.81% had their right hip involved.

Table 2: Tear drop obliteration

Obliteration of Tear Drop	N	%
No	106	99.07
Yes	1	0.93
Grand Total	107	100

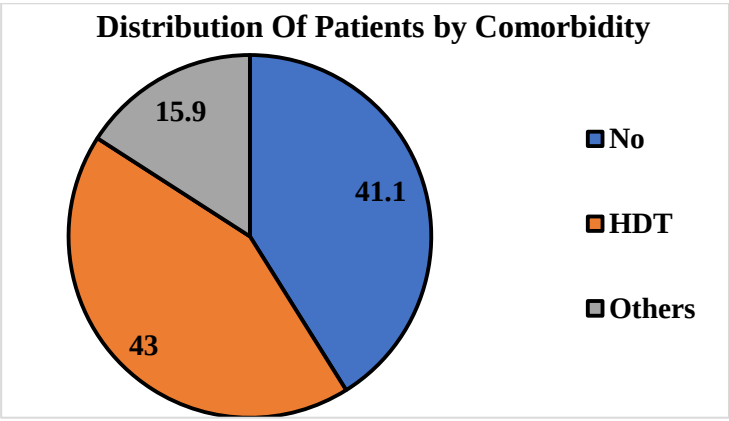
Amongst 107 cases obliteration of tear drop was noted in only one case and 106 cases it was not present.

Figure 5: Distribution of subjects based on Distance from Kohler's line



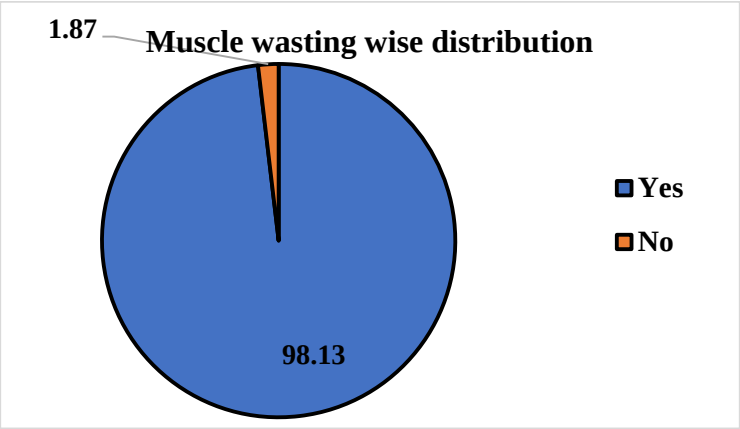
Distribution based on distance from Kohler's line showed that it varied from -1 to +20mm, with 77.57 % the distance noted was 0 mm and 10.28% it was +2mm and remaining 9.75% it was 3 to 20mm.

Figure 6: Medical History Wise Distribution of patients in year 2018-22



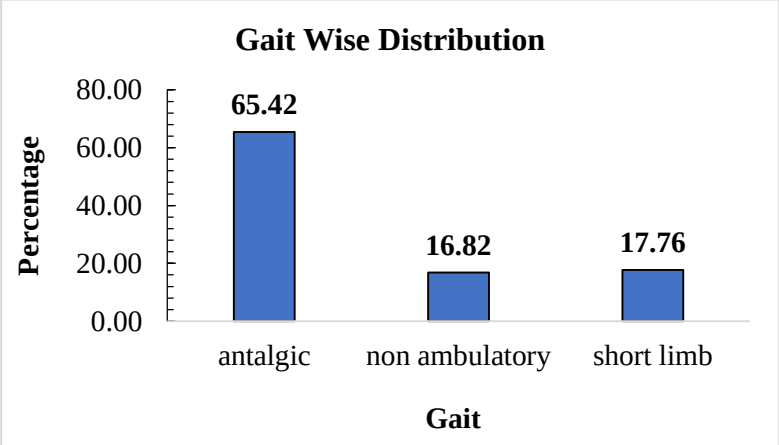
Distribution of patients according to comorbidity stated that 41.1 % (44) cases no comorbidity was present, 43% (46) of cases either suffered from hypertension or diabetes or Thyroid disease were as 15.9% (15) of cases suffered from other comorbidity.

Figure 7: Distribution of patients according Muscle wasting



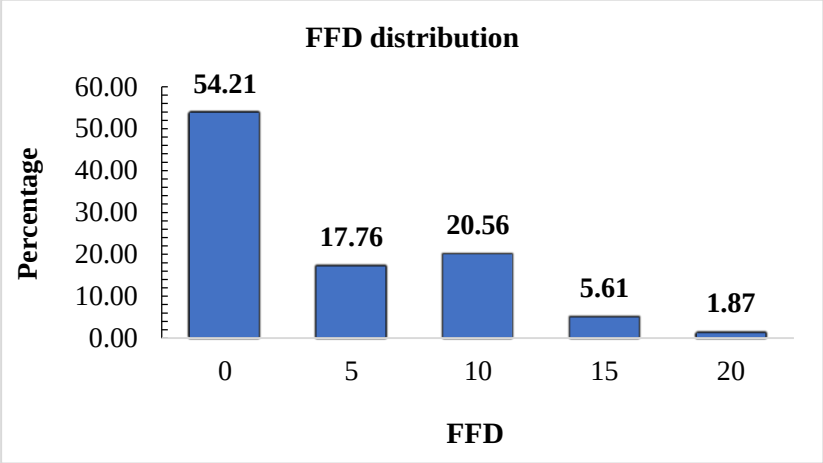
From the above table among 98.13% (105) muscle wasting was noted and only 1.87% (2) cases there was no muscle wasting noted.

Figure 8: Gait Wise Distribution of patients



Gait wise distribution showed that 65.42% (70) had antalgic gait ,16.82% (18) were non ambulatory and 17.76 % (19) had short limb gait.

Figure 9: FFD wise distribution of patients

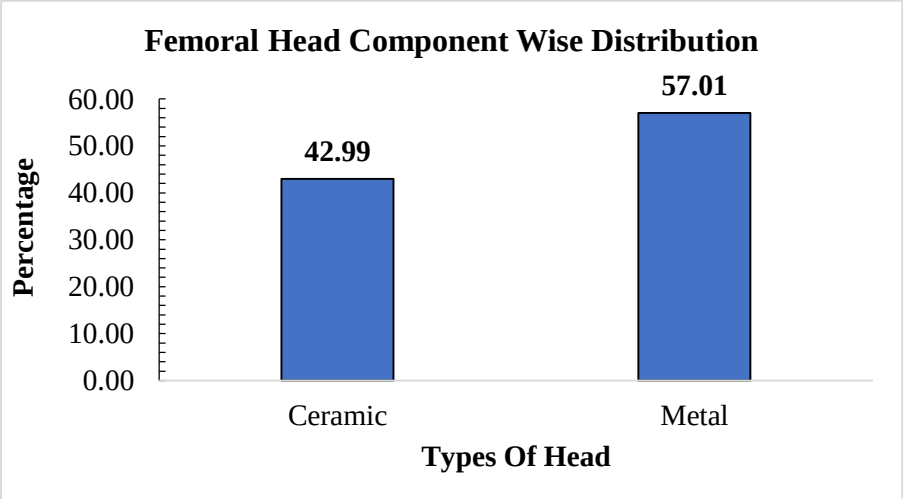


Note: FFD – Fixed flexion deformity

FFD noted was 5 degrees in 17.76 %(19hips), 10 degree was among 20.56% (22 hips), 15 degree was in 5.61% (6 hips) and only 1.87% (2 hips) it was around 20 degree and no FFD present in 54.21% (58 hips).

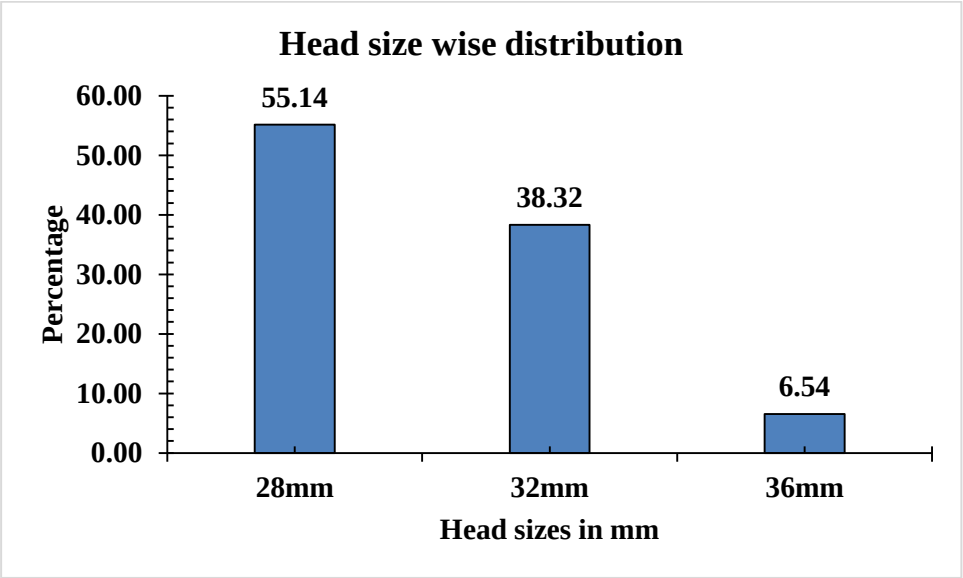
Intra- Operative Factors

Figure 10: Femoral Head Component used Distribution of THA patients



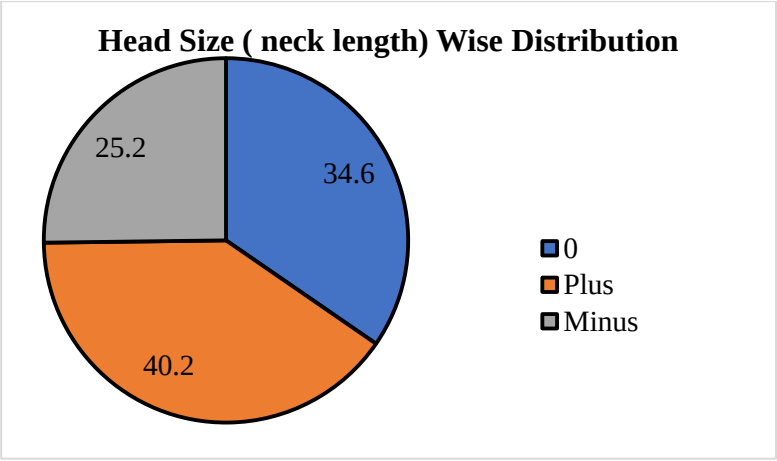
The distribution based the Head used it was noted that 42.99% (46) cases ceramic heads were used and 57.01% (61) metal head was used.

Figure 11: Distribution of THA patients by Implant Head size in diameters



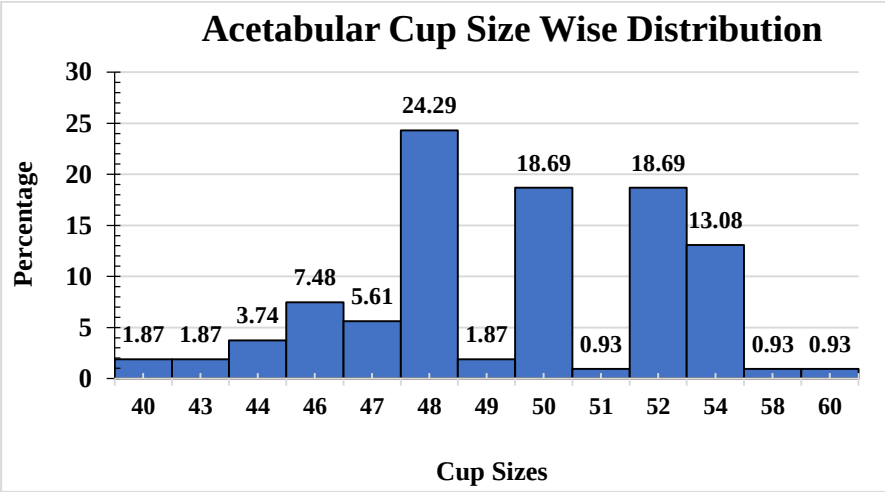
The head sizes used in 107 hips ranged from 28mm to 36mm. 55.14% (58) cases 28mm head size was used, in 38.32% (41) cases 32mm was used, 6.54% (7) cases 36mm head size was used.

Figure 12: Intra Op Head Size (Neck Length Variation) wise distribution of THA patients in 2018-22



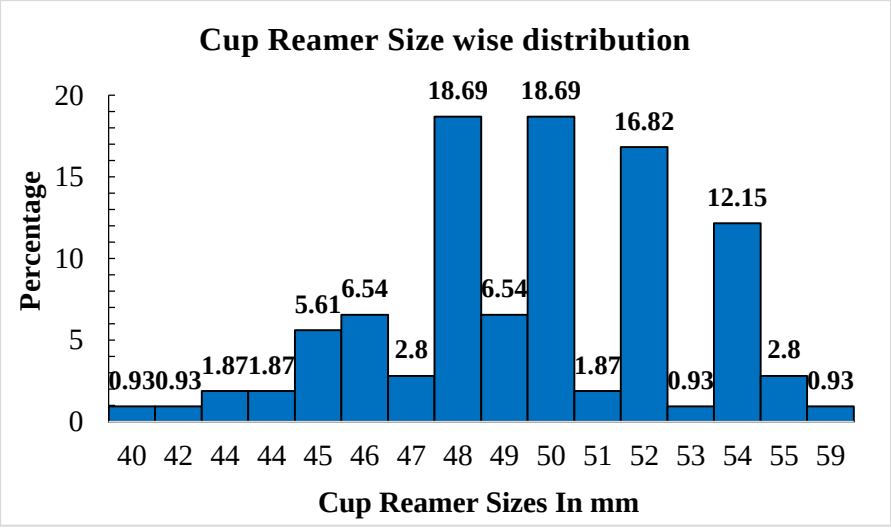
Head sizes with neck length variation in plus were 40.2% (43) and head sizes with neck length in minus were noted in 25.2% (27) and head sizes with neck length 0 were 34.6 % (37).

Figure 13: Distribution of THA Patients by Acetabular Cup Size



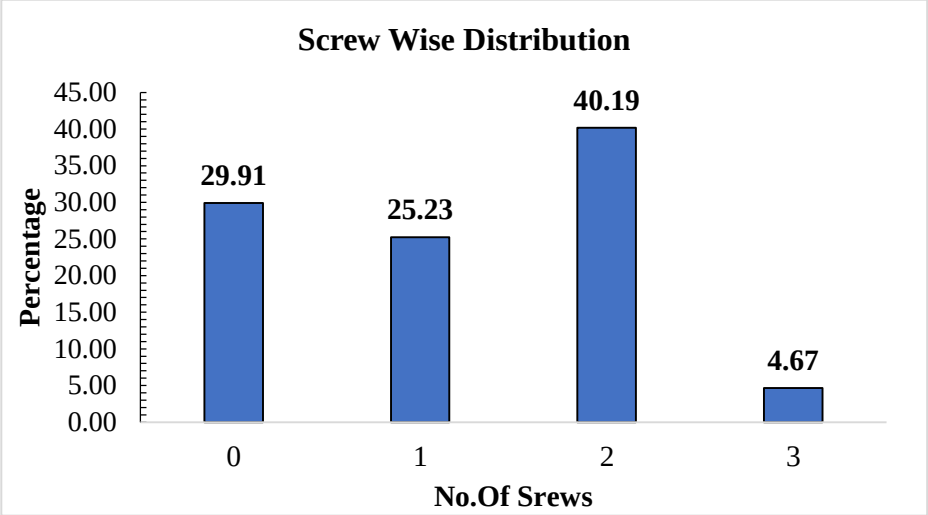
The acetabular cup sizes ranged from 40mm to 60mm. 20.37% <48mm size was used,24.29% had 48mm size, in 18.6% 50mm and 52mm and in 13.08% had 54mm and in just 1.86% (2) patients acetabular cup >54mm was used. 90% of cases had cup sizes between 46 and 54 mm.

Figure 14: Distribution of THA patients by Cup Remer Size



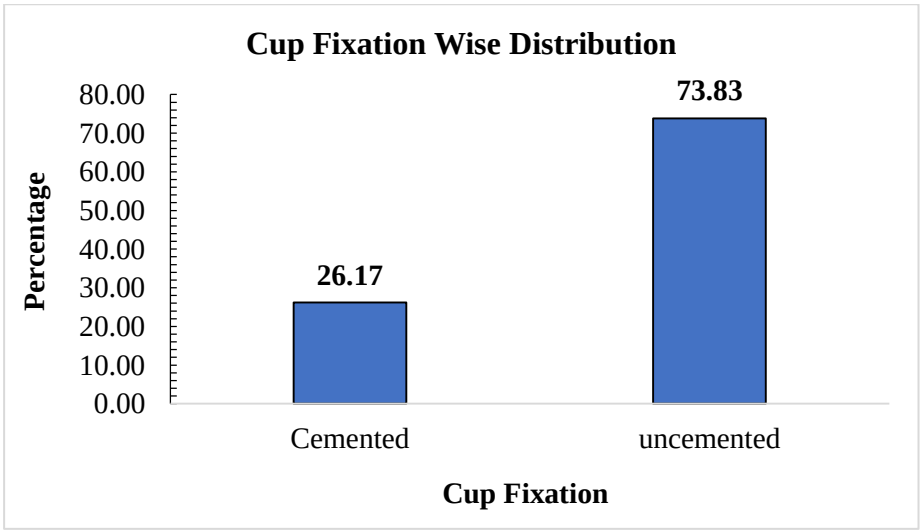
Cup reamer size used in the study had range from 40mm to 59mm.In 18.69% (20 hips) reamer size used was 48mm and 50mm was used for other 20 hips, <48mm size were used in 20.41% (22) and >50mm were used in 35.5% (37) patients.

Figure 15: Distribution of THA patients by Number of Screw used



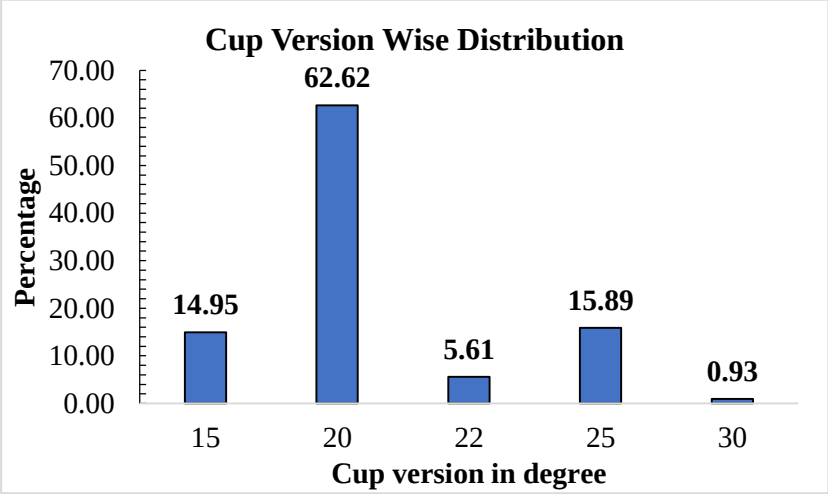
In 29.91% (32) cases of THR no screws were used and 40.19 % (43) of cases 2 screws were used and in 25.23% (27) one screw was used, just in 4.6% (5) 3 screws were used.

Figure 16: **Distribution based on type of Cup fixation**



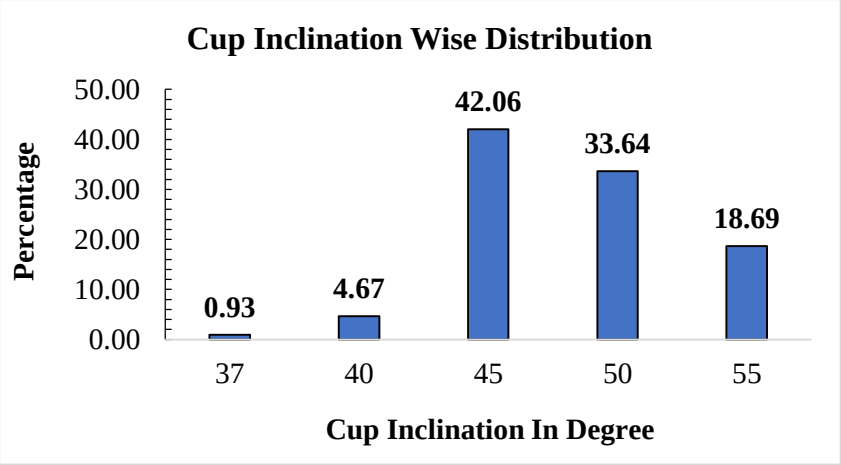
73.83%(79) cases had uncemented cup fixation and in 26.17 %(28) cases cemented cup fixation was done.

Figure 17: **THA patient Distribution by Degree of Cup version**



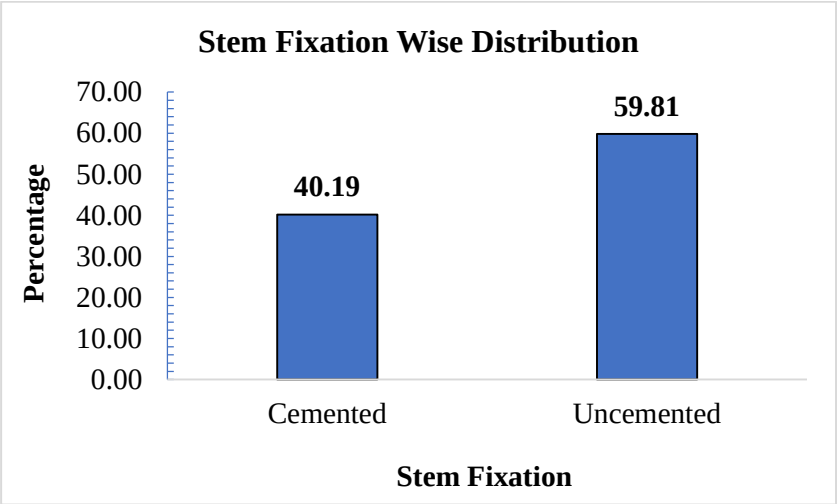
The cup version varied between 15 degrees to 30 degrees with maximum version noted was 20 degrees among 62.62 % (67) cases, just in 0.93% (1) case the version was 30 degrees. 14.95% (16) cases the cup version was 15 degrees ,15.89% (17) cases 25 degree and just 5.61% (6) cases the cup version was 22 degrees.

Figure 18: Cup Inclination wise distribution of THA patients



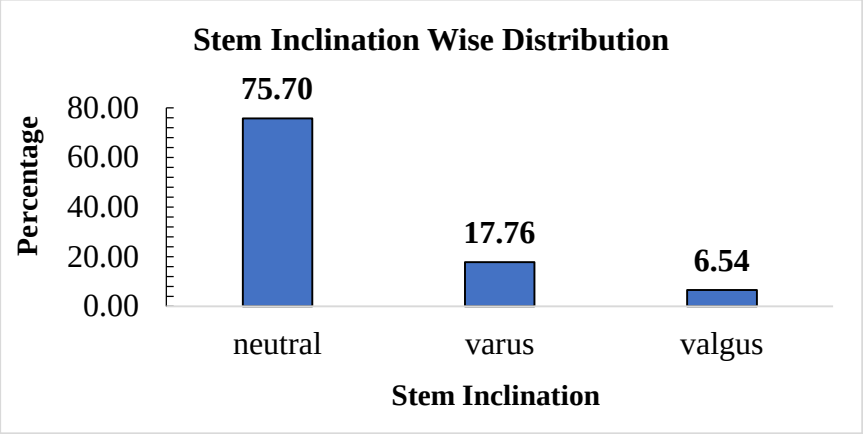
Cup inclination in the study ranges from 37 degree to 55 degree, 0.93% (1 hip) had cup inclination of 37 degrees, 4.67% (5 hips) had inclination of 40 degrees, 42.06 % (45 hips) had cup inclination of 45 degrees, 33.64% (36 hips) had 50 degree and 18.69% (20 hips) had cup inclination of 55 degrees.

Figure 19: **Stem Fixation Wise Distribution of THA patients**



Uncemented Stem fixation was done in 59.81% (64 hips) cases and in remaining 40.19% (43 hips) cemented Stem fixation was done.

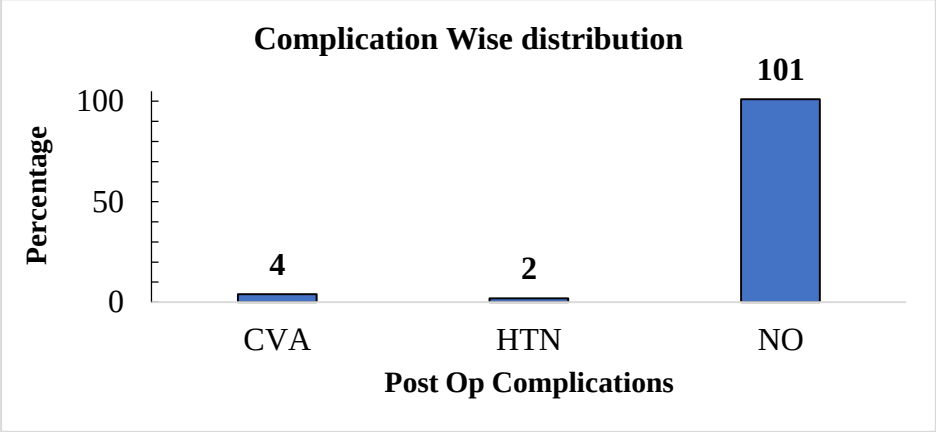
Figure 20: **Distribution of THA patients based on Stem inclination**



Stem inclination analysis suggested as 75.7% (81 stems) were neutral but in 17.76% (19 stems) it was varus and in 6.54% (7 stems) it was valgus.

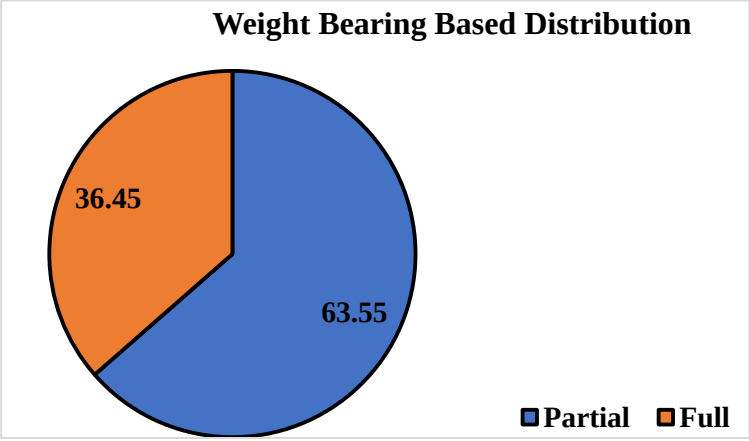
Post operative Variables

Figure 21: **Distribution of THA patients based on post operative complications**



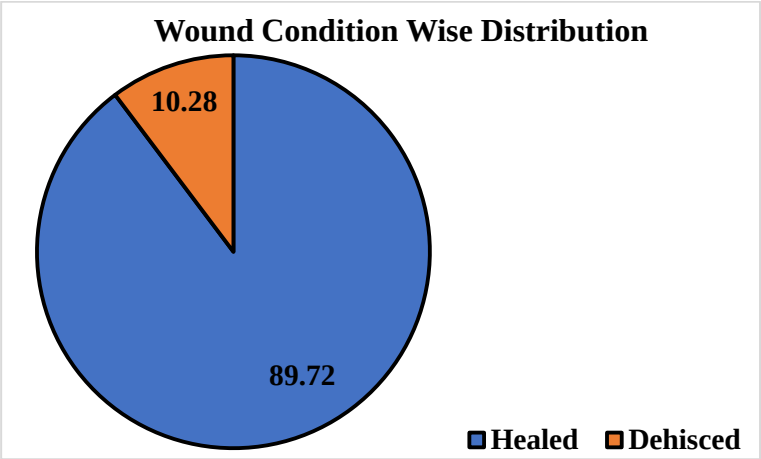
The major complication after THA noted was CVA and incidence of CVA was noted in just 3.74% cases which is 4 out of 107 cases. Minor complication noted was hypertension in just 1.87% (2) cases. No other complication was noted during the study.

Figure 22: **Weight Bearing Based Distribution**



Post operative weight bearing status was partial in 63.55% (68) cases and 36.45% (39) it was full.

Figure 23: **Distribution of patients by post operative wound condition**



The wound was healed in 89.72% (96 hips) in 2 weeks and 10.28% (11 hips) it was dehisced & delayed for 3 weeks with complete healing at 3 weeks.

Figure 24: **Distribution of Patients based on Number of days in Hospital Stay.**

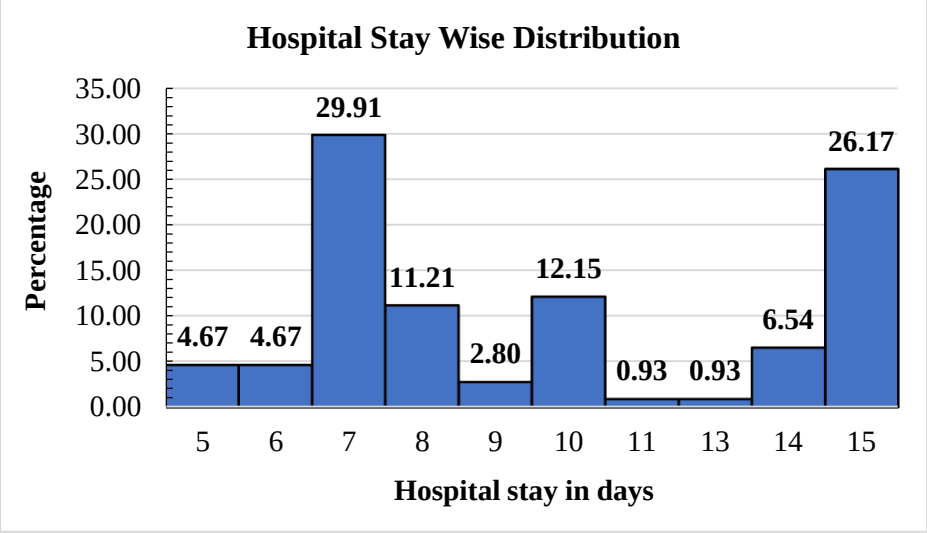
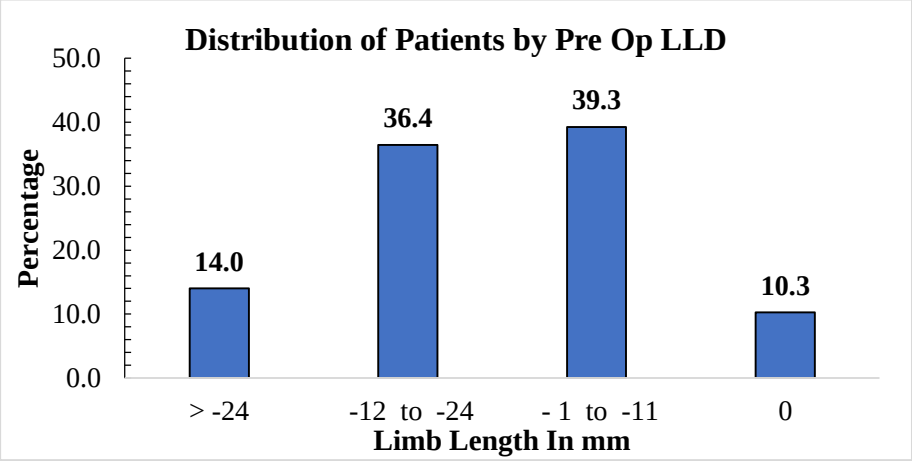


Table 3: Distribution of patients based on hospital stay

Hospital Stay (Weeks)	No of pts	%	Mean	SD
1week or <	42	39.25	10.04	3.58
1week- 2weeks	37	34.58		
>2 weeks	28	26.17		

The hospital stays of patients varied from 5 days to 15 days with average of 10 days and standard deviation of 3.5 days, nearly 39.25% (42 patients) stayed less than a week in the hospital, 34.58% (37 patients) stayed for 1 to 2 weeks and 26.17% (28 patients) stayed for 2 weeks till discharge.

Figure 25: Distribution of patients by pre-operative Limb length Discrepancy



Note: - Op- Operative, LLD- Limb length discrepancy

Pre-operatively LLD was not present in 10.3% (11 hips) whereas 89.7% cases had limb shortening, amongst which shortening of -1 to -11mm was noted in 39.3% (42 hips) and -12 to -24 mm shortening was in 36.4% (39 hips) and > -24mm shortening was noted in 14% (15 hips). [as in the graph **fig 25**, Four groups were identified in patients as 1) with zero LLD 2) LLD from -1 to 11mm 3rd group) -12mm to -24 mm & 4th group) above -24 mm.

Table 4: Distribution of hips by Pre - Intra and post-operative (THA) Limb length Discrepancy

Classification	Groups of LLD (in mm)	Pre-OP LLD (no of hips)	%	Post -OP LLD (no of hips)	%
M3	**< -24**	14	13.1	0	0.0
M2	**-12 to -24**	40	37.4	2	1.9
M1	**-1 to -11**	42	39.3	16	15.0
Restored	**0 mm**	11	10.3	49	45.8
P1	**1 to 11**	0	0.0	34	31.8
P2	**12 to 24**	0	0.0	6	5.6
P3	**> 24**	0	0.0	0	0.0
	Total	107	100%	107	100%

We classified LLD as Restored group for No change in LLD group: Shortened group as Minus LLD or M LLD & Lengthened group as Plus or P LLD groups. Which were further divided as three sub groups respectively.

[M1 is -1 to -11 mm] [M2 is -12 to -24mm] [M3 is -24mm & more shortening]

[P1 is +1 to +11 mm] [P2 is +12 to +24mm] [P3 is +24mm & more lengthening]

Shortening was observed in a range of -40mm to -1mm in 89.7% of Preop LLD group. While in 10.3% (or 11 hips) had no LLD preoperatively.

Table 5 : Ranawats method of Intraoperative achieved corrections

Intra op possible corrected LLD (no of hips)	%
(0mm) 5	4.7
(1-11mm) 46	3.3
(12-24mm) 48	44.9
(25-42mm) 18	16.8
(0 to 42mm) 107	100%

Whereas during surgery, lengthening was resulted in 95.3% (102 hips). LLD was zero mm in 4.7% (or 5 hips) designated as neutral group. Post op LLD was Restored in 45.8% (49) and there was shortening in 16.9% (18) with maximum shortening of 14mm and minimum of 1 mm but nearly 37.38% (40) hips were lengthened and maximum lengthening noted was 20mm. Mean LLD in Pre op hips was -13.8mm, intra op corrected mean LLD was 15.7mm and post op mean LLD was 1.8 mm.

Table 6: Mean & SD of Pre to Post LLD groups:

	Preop LLD	Intra-op correction of LLD	Post Op LLD
Mean	-13.8mm	15.7mm	1.8mm
SD	9.3	8.9	6.8
Minimum	-40mm	0	-14mm
Maximum	0	42mm	20mm

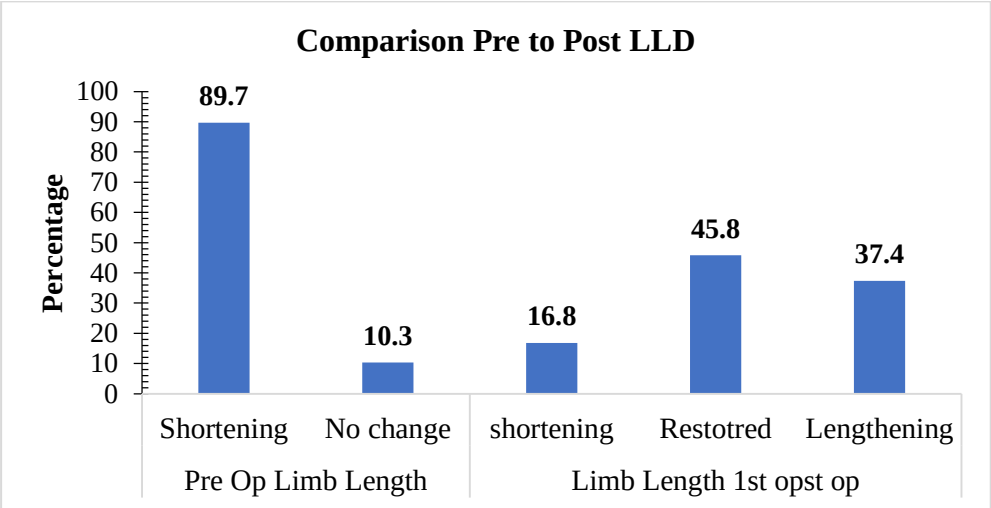
Table 7: Comparison of LLD from Pre op to Intra Op by using t-test

LLD	Mean	n	SD	SE	t test (df)	P-value
Preop True Clinical Shortening (LLD)	13.98	107	9.59	0.93	17.81 (106)	<0.001**
Intra op Correction	15.54	107	9.03	0.87		

Note: LLD- Limb length Discrepancy, df- degree of freedom, **- highly significant

The difference in LLD from pre -operative to intra op was tested through t-test statistics and the value was 17.81 at 106 df which is highly significant with p value <0.001. Hence there was difference in means of two groups and through the means we can say that significant correction (15.54mm) was done intraoperatively.

Figure 26: Comparison LLD Pre Op to Post Op



Note: - Op- Operative, LLD- Limb length discrepancy

Table 8: Comparison of LLD from Pre-Op to Post Op Day Using t-test

LLD	n	%	Mean	Median	SD	Minimum	Maximum	t test	p- value
Shortening									
Pre-Op Limb Length	96	89.7	-15.6	-15	8.8	-40	-1	7.8	<0.01*
Post Op	18	16.8	-9.7	-10	5.2	-14	-5		
No change/Restored									
Pre-Op Limb Length	11	10.3	-	-	-	-	-	-	-
Post Op	49	45.8	-	-	-	-	-		
Lengthening									
Pre-Op Limb Length	0	0	0	0	0	0	0	3.1	<0.01*
Post Op	40	37.4	8.7	10	4.2	2	20		

Notes: *- significant

Comparison between pre-op LLD and Post Operative LLD was done using t test statistics and shows that there is significant difference in means of all three LLD groups with $p<0.001$. Through the percentage, the shortening cases reduced from 89.7% to just 16.8% post operatively and NO LLD cases increased from 10.3% to 45.8%, means LLD was restored significantly, but nearly 37.4% cases happened to lengthen postoperatively.

Table 9: Comparison of post operative LLD at different Time Point (follow ups)

Duration	Limb Length	n	Mean	Std. Deviation	Minimum	Maximum	F- Test (3,424)	P- Value
Post Op Day	shortening	18	-9.6	5.2	-28	-5		
	Restored	49	0	0	0	0		
	Lengthening	40	8.7	4.1	2	20		
	Total	107	1.6	7.3	-28	20		
14- 21 Days	shortening	18	-9.7	5.2	-28	-5		
	Restored	49	0	0	0	0		
	Lengthening	40	8.7	4.2	2	20		
	Total	107	1.6	7.3	-28	20		
6 Weeks	shortening	18	-9.7	5.2	-28	-5		
	Restored	49	0	0	0	0		
	Lengthening	40	8.7	4.2	2	20	0	>0.05
	Total	107	1.6	7.3	-28	20		
3 Months	shortening	18	-9.7	5.2	-28	-5		
	Restored	49	0	0	0	0		
	Lengthening	40	8.7	4.2	2	20		
	Total	107	1.6	7.3	-28	20		
6 Months	shortening	18	-9.7	5.2	-28	-5		
	Restored	49	0	0	0	0		
	Lengthening	40	8.7	4.2	2	20		
	Total	107	1.6	7.2	-28	20		

Change in LLD post operatively over every follow up was assessed through f test and the f- value came to be 0 hence p value >0.05 which is non-significant and also the mean at every follow up was 9.66mm in shortening group and 8.77mm in lengthening group, thus there was no change in LLD Post operatively over different time points.

Table 10: Multinomial Logistic Regression to study the determinants of LLD (in the shortened group of 18 hips)

Variables in the Equation	B	S.E.	Wald	df	p-value	Odds Ratio	95% C.I. for Odds Ratio	
							Lower	Upper
Age								
<40								
40-59	-1.476	1.02	2.095	1	0.148	0.23	0.03	1.69
60+	-3.624	1.433	6.396	1	0.011	0.03	0.00	0.44
Gender								
Male								
Female	0.736	0.703	1.094	1	0.296	2.09	0.53	8.28
Diagnosis								
AVN								
Post traumatic OA	2.529	1.322	3.663	1	0.056	12.54	0.94	167.24
OA	1.733	0.973	3.17	1	0.075	5.66	0.84	38.12

Inflammatory Arthropathy	-0.832	1.475	0.318	1	0.573	0.44	0.02	7.84
Fracture hip	1.692	1.075	2.48	1	0.115	5.43	0.66	44.65
DDH	-0.726	1.578	0.212	1	0.645	0.48	0.02	10.66
Comorbidity								
No								
HDT	1.069	0.858	1.551	1	0.213	2.91	0.54	15.65
Others	-	-	-	-	-	-	-	-
Cup Size								
40-49								
50-60	-0.654	0.742	0.776	1	0.378	0.52	0.12	2.23
Head Diameter								
28								
32	0.391	0.823	0.226	1	0.635	1.48	0.30	7.42
36	1.254	1.51	0.69	1	0.406	3.50	0.18	67.57
Head Variation								
0								
Plus	-2.386	0.936	6.499	1	0.011	0.09	0.02	0.58
Minus	-1.352	0.906	2.226	1	0.136	0.26	0.04	1.53

Stem Inclination								
Neutral								
Varus	0.935	0.979	0.911	1	0.34	2.55	0.37	17.36
Valgus	3.122	1.482	4.437	1	0.035	22.69	1.24	414.46

From the table above salient results are:

a. Age is significant factor, shortening cases were significantly lower in 60+ age group patients than <40 age group.
b. Gender: - there are shortening cases in females 2 times higher than males but it is having no much significance.
c. Diagnosis: - the shortening case were higher in OA and post traumatic cases and fractures patients as compared to AVN cases.
d. Co-morbidity: - Not significant influence may be less sample as there were no cases in other comorbidity group.
e. Head variation: - shortening cases were lower in plus head variation group in comparison to no variation group.
f. Head Diameter: - not significant influencer
g. Stem Inclination: Is an independent influential variable.

Analysis suggested influence of stem inclination in the shortening group for valgus stems, As *p*-value of 0.03 has strong association. Specifically, hips with valgus stems are about 22.69 times more likely to be in the shortened LLD group compared to hips with neutral stems.

Figure 27: ROC Curve – The Regression Model used for measuring shortening cases is Significant with P value <0.001 with 77% sensitivity and 79% specificity

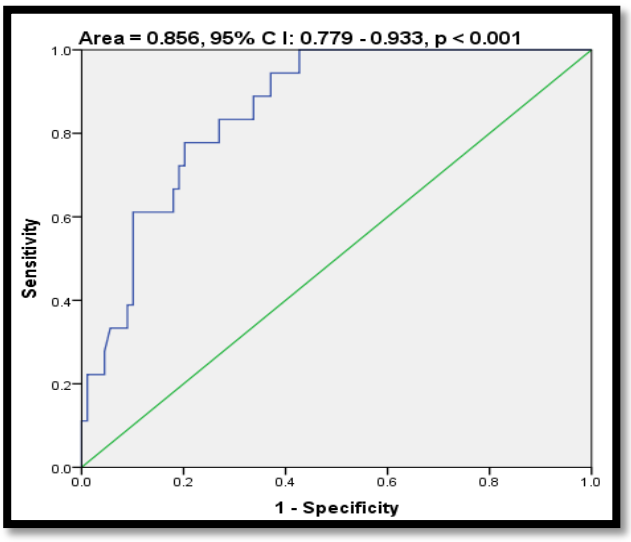


Table 11: Coordinates of the Curve (Predicted probability)

Positive if Greater Than or Equal Toa	Sensitivity	specificity
0.090986	0.944	0.629
0.120134	0.889	0.663
0.19404	0.833	0.73
# 0.237643	0.778	0.798
0.260702	0.722	0.809
0.283058	0.667	0.82
0.328334	0.611	0.899
0.388163	0.389	0.91
0.430395	0.333	0.944
0.562187	0.222	0.989

Notes :- # - coordinate at which sensitivity and specificity are nearly equal to each other

Table 12: Multinomial Logistic Regression to study the determinants of LLD

(Lengthened Group of 40hips)

Variables/Factors	B	S.E.	Wald	df	p-value	Odds Ratio	95% C.I. for Odds Ratio	
							Lower	Upper
AGE								
<40								
40-59	-1.207	0.751	2.583	1	0.108	0.299	0.069	1.303
60+	-1.658	0.891	3.465	1	0.063	0.19	0.033	1.092
Gender								
Male								
Female	0.187	0.534	0.122	1	0.727	1.205	0.423	3.431
Diagnosis								
AVN								
Post traumatic OA	-0.794	0.96	0.685	1	0.408	0.452	0.069	2.964
OA	-0.321	0.617	0.27	1	0.603	0.726	0.217	2.431
Inflammatory Arthropathy	-0.415	0.987	0.177	1	0.674	0.66	0.095	4.568
Fracture hip	0.091	0.757	0.015	1	0.904	1.096	0.248	4.834
DDH	-	-	-	-	-	-	-	-
Comorbidity								
No								
HDT	1.18	0.61	3.745	1	0.053	3.253	0.985	10.745
Others	1.223	0.704	3.014	1	0.083	3.397	0.854	13.512

Cup size								
40-49								
50-60	-0.278	0.505	0.303	1	0.582	0.757	0.281	2.037
Head Diameter								
28								
32	-0.669	0.549	1.484	1	0.223	0.512	0.175	1.503
36	-0.12	1.04	0.013	1	0.908	0.887	0.115	6.814
Head Variation								
0								
Plus	0.54	0.535	1.019	1	0.313	1.717	0.601	4.902
Minus	-1.271	0.7	3.293	1	0.07	0.281	0.071	1.107
Stem Inclination								
Neutral								
Varus	-0.578	0.681	0.721	1	0.396	0.561	0.148	2.13
Valgus	-0.812	1.099	0.546	1	0.46	0.444	0.052	3.826

a. Age**: -** this has significant influence on LLD as the cases of lengthening are comparatively less in 40-59 and 60+ groups as compared to <40 age group.
b. Gender: - this has very less influence on LLD. in female lengthening cases were higher than male but not significant.
c. Comorbidity: - this has significant influence on LLD as HDT and other group have 3 times higher risk of Lengthening in comparison with no comorbidity group.
d. Diagnosis: - this has very less influence on LLD.

e. Head diameter: - this is not a significant influencing factor for lengthening. Head variation: - this has significant influence on LLD as minus group has less chance of lengthening in comparison to plus and 0. And lengthening cases were more in plus head variation group than 0 head variation.

f. Stem inclination is very less influencing factor on LLD, valgus and varus group had 4 times higher lengthening cases than neutral group.

g. Cup size : this has less influence on LLD (lengthening) but as the cup size with 50-60 has nearly 70% chances of lengthening than cup sizes of 40-49.

Overall significantly influencing factors for lengthening are head variation, comorbidity and age other are less influencing factors .

Figure 28: ROC Curve – The Regression Model used is Significant with P value <0.001 with 60% sensitivity and 67% specificity

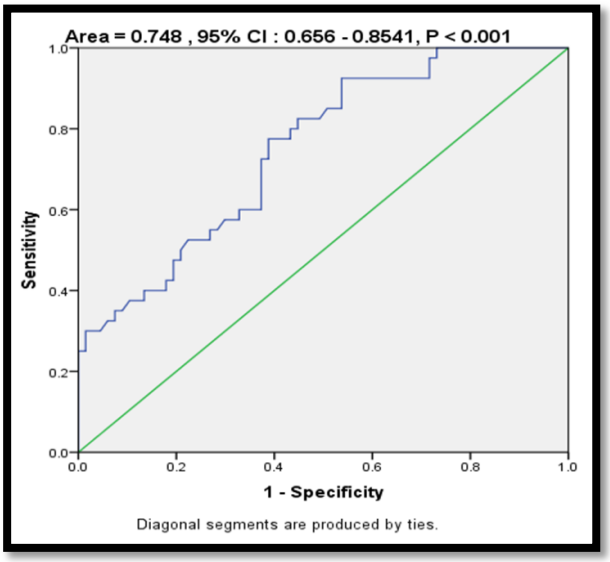


Table 13: Coordinates of the Curve (Predicted probability)

Positive if Greater Than or Equal Toa	Sensitivity	specificity
0.140717	0.975	0.284
0.252767	0.925	0.463
0.260308	0.900	0.463
0.269305	0.850	0.493
0.297659	0.825	0.552
0.321126	0.800	0.567
0.35989	0.775	0.612
0.380703	0.725	0.627
# 0.416418	0.600	0.672
0.431803	0.575	0.701
0.443795	0.550	0.731
0.498823	0.525	0.776
0.528877	0.500	0.791
0.548136	0.425	0.821
0.562161	0.400	0.866
0.569671	0.375	0.896
0.573056	0.350	0.925
0.594135	0.325	0.940
0.625394	0.300	0.985

Notes: - coordinate at which sensitivity and specificity are nearly equal to each other

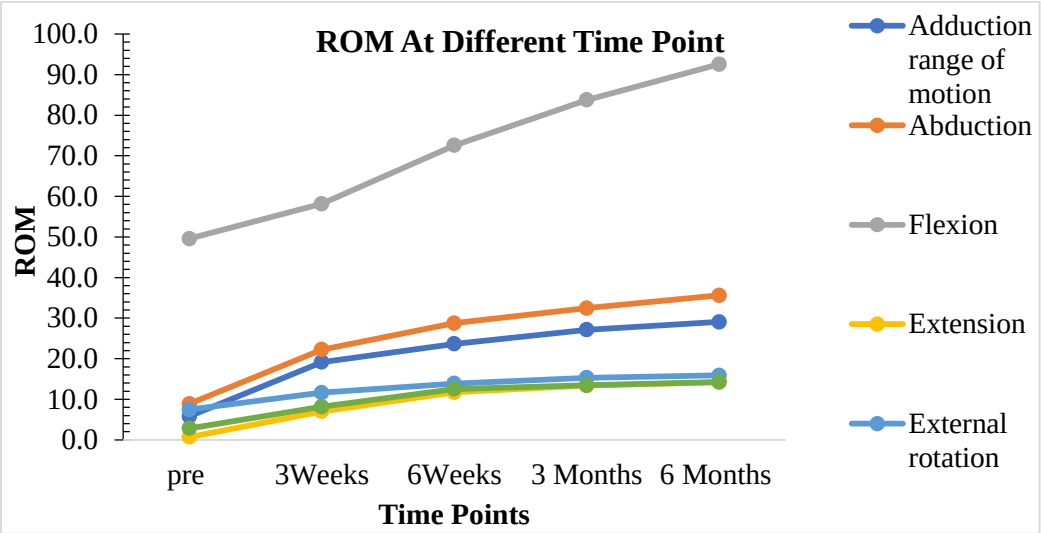
Table 14: Comparison of ROM at Different Time Points Using t Statistics

ROM At different Time points	Median (IQR)	t-value	p-value
Adduction Pre operative	5 (10)	-	-
Adduction 2-3 weeks	20 (10)	-8.099	<0.001**
Adduction 6 weeks	25 (10)	-8.674	<0.001**
Adduction 3 Months	30 (5)	-8.949	<0.001**
Adduction 6 Months	30 (0)	-9.027	<0.001**
Abduction Pre operative	10 (15)		
Abduction 2-3 weeks	25 (10)	-7.749	<0.001**
Abduction 6 weeks	30 (5)	-8.534	<0.001**
Abduction 3 Months	30 (10)	-8.864	<0.001
Abduction 6 Months	40 (10)	-8.869	<0.001
Flexion Pre operative	45 (40)	-	-
Flexion 2-3 weeks	50 (35)	-2.88	0.004*
Flexion 6 weeks	70 (30)	-6.225	<0.001**
Flexion 3 Months	80 (15)	-8.144	<0.001**
Flexion 6 Months	90 (10)	-8.663	<0.001**
Extension Pre operative	0		
Extension 2-3 weeks	10 (5)	-7.485	<0.001**
Extension 6 weeks	10 (5)	-8.856	<0.001**

Extension 3 Months	10 (5)	-8.862	<0.001**
Extension 6 Months	15 (5)	-9.055	<0.001**
External rotation Pre operative	10 (10)		
External rotation 2-3 weeks	10 (5)	-3.489	<0.001**
External rotation 6 weeks	15 (5)	-5.721	<0.001**
External rotation 3 Months	15 (5)	-6.482	<0.001**
External rotation 6 Months	15 (5)	-6.826	<0.001**
Internal rotation Pre operative	0		
Internal rotation 2-3 weeks	10 (5)	-7.594	<0.001**
Internal rotation 6 weeks	15 (5)	-8.497	<0.001**
Internal rotation 3 Months	15 (5)	-8.731	<0.001**
Internal rotation 6 Months	15 (0)	-8.892	<0.001**

Notes: - *- significant, **- highly significant, IQR- inter quartile range

Figure 29: Trend line showing Improvement in ROM at different time points.



Notes: - ROM- Range of motion, Pre- Pre operative

The comparison of ROM – Abduction, adduction, flexion, extension, internal rotation and external rotation all independently at different time point was done using t -test statistics and has come significant with p value <0.001, indicating improvement in ROM, as the median value is significantly increasing over the time and the negative value of t statistics confirm the increase in ROM over the time, the same is shown through the trendline graph. The increasing trend can be seen in all the ROM over different time point from pre- operation to post operative and 6 months after operation.

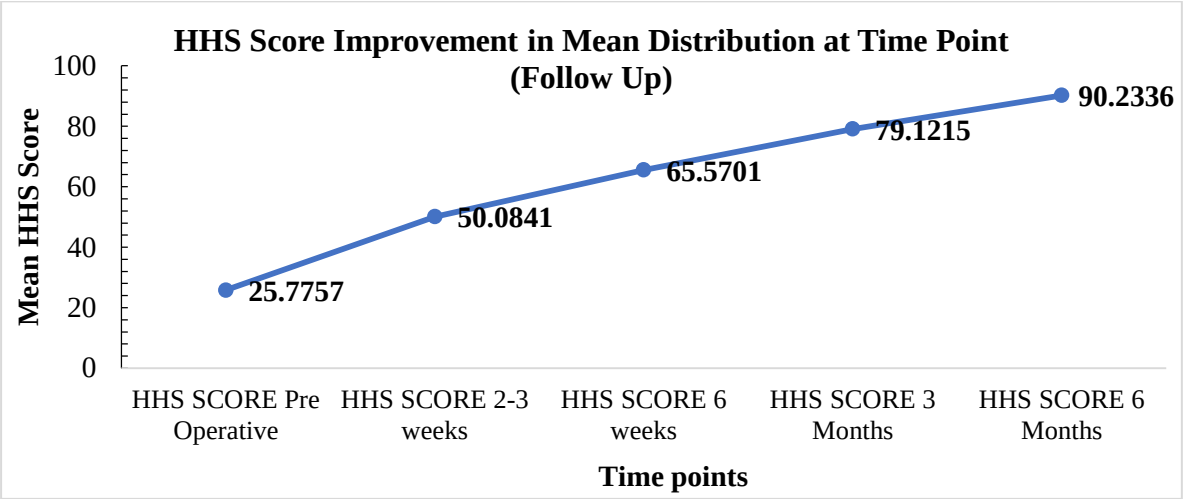
Table 15: Comparison of HHS Score at different Time Point Using Paired t Test

	Paired Samples Test			95% Confidence Interval of the Difference			
HHS Score Different Time Point	**Mean Differences**	**S.D Differences**	**S.E Mean**	**Lower**	**Upper**	**t-value**	**P-Value**
pre - 14th post operative	-24.3	11.2	1.1	-26.4	-22.2	-22.5	<0.001**
14th post op day to - 6weeks	-15.5	5.3	0.5	-16.5	-14.5	-30.1	<0.001**
6Weeks to 3rd months	-13.6	4.5	0.4	-14.4	-12.7	-31.1	<0.001**
3rd month to 6th month	-11.1	3	0.3	-11.7	-10.5	-38.8	<0.001**
Pre operative to 6Weeks	-39.8	9.6	0.9	-41.6	-38	-43	<0.001**
Pre-Operative to 3rd month	-53.3	11.2	1.1	-55.5	-51.2	-49.2	<0.001**
Pre operative to 6 th Months	-64.5	11.7	1.1	-66.7	-62.2	-57.2	<0.001**

Notes: - HHS- Harris hip score, M- Mean, SD- standard deviation, SE- standard error, **- highly significant

Comparison of HHS score at different time point was done using t test statistics and has come significant with $p<0.001$ indicating difference in mean HHS score over different time point the mean HHS score is increasing at every follow up implying improvement in outcome.

Figure 30: Trend Line Showing Improvement in HHS Score at Different Time Point



The trendline is clearly showing the increasing trend in Mean HHS score from Pre-operative (25.77) time period to 6 months (90.23) post operatively.

Table 16: Association of LLD with Patient reported Function Outcome (HHS Score) and Clinical Outcome (ROM) Using Chi Square Test statistics.

HHS/ROM		LLD								Chi- Sq	P-value
		shortened		Restored		Lengthened		Total			
		n	%	n	%	n	%	n	%		
HHS Pre – Op	Poor	18	100	49	100	40	100	107	100		
	Fair	0	0	0	0	0	0	0	0		
	Good	0	0	0	0	0	0	0	0		
	Excellent	0	0	0	0	0	0	0	0	-	-
HHS 3 Weeks	Poor	18	100	49	100	40	100	107	100		
	Fair	0	0	0	0	0	0	0	0		
	Good	0	0	0	0	0	0	0	0		
	Excellent	0	0	0	0	0	0	0	0	-	-
HHS 6 Weeks	Poor	14	77.8	39	79.6	31	77.5	84	78.5		
	Fair	4	22.2	10	20.4	9	22.5	23	21.5		
	Good	0	0	0	0	0	0	0	0		
	Excellent	0	0	0	0	0	0	0	0	0.06 (2)	0.97
HHS 3 Months	Poor	0	0	0	0	0	0	0	0		
	Fair	10	55.6	26	53.1	19	47.5	55	51.4		
	Good	8	44.4	23	46.9	21	52.5	52	48.6		
	Excellent	0	0	0	0	0	0	0	0	0.42 (2)	0.81
HHS 6 Months	Poor	0	0	0	0	0	0	0	0		
	Fair	0	0	0	0	0	0	0	0	0.05 (2)	0.98

	Good	9	50	23	46.9	19	47.5	51	47.7		
	Excellent	9	50	26	53.1	21	52.5	56	52.3		
FFD Groups	0	11	61.1	28	57.1	19	47.5	58	54.2		
	01-10	5	27.8	16	32.7	20	50	41	38.3		
	>10	2	11.1	5	10.2	1	2.5	8	7.5	5.06 (4)	0.28
Adduction (pre-op)	0	7	38.9	23	46.9	16	40	46	43		
	1-20	11	61.1	25	51	23	57.5	59	55.1		
	>20	0	0	1	2	1	2.5	2	1.9	1.07 (4)	0.90
Abduction (pre-op)	0	5	27.8	15	30.6	15	37.5	35	32.7		
	1-20	11	61.1	31	63.3	20	50	62	57.9		
	>20	2	11.1	3	6.1	5	12.5	10	9.3	2.22 (4)	0.70
Flexion (pre-op)	<30	5	27.8	19	38.8	16	40	40	37.4		
	30-60	6	33.3	15	30.6	9	22.5	30	28		
	>60	7	38.9	15	30.6	15	37.5	37	34.6	1.70 (4)	0.79
Extension (pre-op)	0	15	83.3	46	93.9	39	97.5	100	93.5		
	01-10	1	5.6	2	4.1	1	2.5	4	3.7		
	>10	2	11.1	1	2	0	0	3	2.8	6.26 (4)	0.18
external rotation (pre-op)	0	5	27.8	18	36.7	12	30	35	32.7		
	01-10	7	38.9	23	46.9	17	42.5	47	43.9		
	>10	6	33.3	8	16.3	11	27.5	25	23.4	2.79 (4)	0.59
Internal rotation (pre-op)	0	14	77.8	34	69.4	34	85	82	76.6		
	01-10	4	22.2	13	26.5	5	12.5	22	20.6		
	>10	0	0	2	4.1	1	2.5	3	2.8	3.65 (4)	0.46
Adduction	0	0	0	0	0	0	0	0	0	3.50 (4)	0.17

at 3 Weeks	01-20	10	55.6	38	77.6	26	65	74	69.2		
	>20	8	44.4	11	22.4	14	35	33	30.8		
Abduction at 3 Weeks	0	0	0	0	0	0	0	0	0		
	01-20	8	44.4	25	51	20	50	53	49.5		
	>20	10	55.6	24	49	20	50	54	50.5	0.23(4)	0.89
Flexion at 3 Weeks	<30	4	22.2	2	4.1	5	12.5	11	10.3		
	30-60	7	38.9	28	57.1	17	42.5	52	48.6		
	>60	7	38.9	19	38.8	18	45	44	41.1	6.15 (4)	0.19
Extension at 3 Weeks	0	2	11.1	11	22.4	2	5	15	14		
	01-10	15	83.3	36	73.5	36	90	87	81.3		
	>10	1	5.6	2	4.1	2	5	5	4.7	5.74 (4)	0.21
External rotation at 3weeks	0	1	5.6	0	0	0	0	1	0.9		
	01-10	11	61.1	35	71.4	25	62.5	71	66.4		
	>10	6	33.3	14	28.6	15	37.5	35	32.7	5.84 (4)	0.21
Internal rotation at 3 Weeks	0	5	27.8	9	18.4	4	10	18	16.8		
	01-10	10	55.6	34	69.4	28	70	72	67.3		
	>10	3	16.7	6	12.2	8	20	17	15.9	3.75 (4)	0.44
Adduction at 6weeks	0	0	0	0	0	0	0	0	0		
	01-20	8	44.4	23	46.9	16	40	47	43.9		
	>20	10	55.6	26	53.1	24	60	60	56.1	0.43 (2)	0.81
Abduction at 6 weeks	0	0	0	0	0	0	0	0	0		
	01-20	5	27.8	12	24.5	9	22.5	26	24.3		
	>20	13	72.2	37	75.5	31	77.5	81	75.7	0.19 (2)	0.91
Flexion at 6	<30	0	0	0	0	0	0	0	0	2.30 (2)	0.32

weeks	30-60	8	44.4	22	44.9	12	30	42	39.3		
	>60	10	55.6	27	55.1	28	70	65	60.7		
Extension at 6 weeks	0	0	0	0	0	0	0	0	0		
	01-10	13	72.2	35	71.4	28	70	76	71		
	>10	5	27.8	14	28.6	12	30	31	29	0.04 (2)	0.98
External rotation at 6 weeks	0	0	0	0	0	0	0	0	0		
	01-10	5	27.8	22	44.9	17	42.5	44	41.1		
	>10	13	72.2	27	55.1	23	57.5	63	58.9	1.64 (2)	0.44
Internal rotation at 6 weeks	0	0	0	0	0	0	0	0	0		
	01-10	8	44.4	27	55.1	18	45	53	49.5		
	>10	10	55.6	22	44.9	22	55	54	50.5	1.12 (2)	0.57
Adduction at 3 Months	0	0	0	0	0	0	0	0	0		
	01-20	3	16.7	7	14.3	5	12.5	15	14		
	>20	15	83.3	42	85.7	35	87.5	92	86	0.18 (2)	0.91
Abduction at 3 Months	0	0	0	0	0	0	0	0	0		
	01-20	2	11.1	3	6.1	2	5	7	6.5		
	>20	16	88.9	46	93.9	38	95	100	93.5	0.78 (2)	.68
Flexion at 3 Months	<30	0	0	0	0	0	0	0	0		
	30-60	1	5.6	2	4.1	1	2.5	4	3.7		
	>60	17	94.4	47	95.9	39	97.5	103	96.3	0.35 (2)	0.84
Extension at 3 Months	0	0	0	0	0	0	0	0	0		
	01-10	12	66.7	26	53.1	21	52.5	59	55.1		
	>10	6	33.3	23	46.9	19	47.5	48	44.9	1.17 (2)	0.56

External rotation at 3 Months	0	0	0	0	0	0	0	0	0	0.18 (2)	0.91
	01-10	3	16.7	10	20.4	7	17.5	20	18.7		
	>10	15	83.3	39	79.6	33	82.5	87	81.3		
Internal rotation at 3 Months	0	0	0	0	0	0	0	0	0		
	01-10	3	16.7	21	42.9	12	30	36	33.6		
	>10	15	83.3	28	57.1	28	70	71	66.4	4.43 (2)	0.11
Adduction at 6 Months	0	0	0	0	0	0	0	0	0		
	01-20	0	0	1	2	1	2.5	2	1.9		
	>20	18	100	48	98	39	97.5	105	98.1	0.44 (2)	0.80
Abduction at 6 Months	0	0	0	0	0	0	0	0	0		
	01-20	1	5.6	1	2	0	0	2	1.9		
	>20	17	94.4	48	98	40	100	105	98.1	2.10 (2)	0.35
Flexion at 6 Months	<30	0	0	0	0	0	0	0	0		
	30-60	0	0	1	2	1	2.5	2	1.9		
	>60	18	100	48	98	39	97.5	105	98.1	0.44 (2)	0.80
Extension at 6 Months	0	0	0	0	0	0	0	0	0		
	01-10	4	22.2	18	36.7	11	27.5	33	30.8		
	>10	14	77.8	31	63.3	29	72.5	74	69.2	1.63 (2)	0.44
External rotation at 6 Months	0	0	0	0	0	0	0	0	0		
	01-10	2	11.1	7	14.3	3	7.5	12	11.2		
	>10	16	88.9	42	85.7	37	92.5	95	88.8	1.02 (2)	0.60
Internal rotation at 6 Months	0	0	0	0	0	0	0	0	0		
	01-10	3	16.7	13	26.5	3	7.5	19	17.8	5.48	
	>10	15	83.3	36	73.5	37	92.5	88	82.2	(2)	0.07

Notes:- HHS- Harris hip score, LLD- limb length discrepancy , ROM- Range of motion, n- no of subjects

The association between LLD Groups and HHS and ROM was studied using chi square test statistics the findings were suggestive of no association with any of the Rom at different time point, nor there was any association with HHS score at different time points as the p>0.05

Table 17: F-test to see the variation of ROM across LLD Groups

Limb Length post op	**shortening**			**Restored**			**Lengthening**			**Test**	
	M	n	SD	M	n	SD	M	n	SD	F-value	P-value
Pre HHS	29.6	18.0	7.9	25.7	49.0	13.3	24.2	40.0	13.4	1.2	0.3
HHS 3 at weeks	50.8	18.0	4.8	50.0	49.0	4.7	49.9	40.0	4.9	0.2	0.8
HHS at 6Weeks	67.2	18.0	4.5	65.8	49.0	5.2	64.6	40.0	5.6	1.7	0.2
HHS at 3Months	79.7	18.0	2.9	78.7	49.0	3.2	79.4	40.0	3.4	0.8	0.5
HHS at 6Months	90.2	18.0	3.5	90.2	49.0	3.7	90.3	40.0	4.0	0.0	1.0
	3.9	18.0	5.6	4.1	49.0	5.6	4.4	40.0	5.0	0.1	0.9
Range Of Motion											
Adduction (pre-op)	6.1	18.0	5.8	5.8	49.0	7.2	7.9	40.0	8.8	0.9	0.4
Abduction (pre-op)	11.7	18.0	9.7	8.9	49.0	8.2	10.5	40.0	10.1	0.7	0.5
Flexion (pre-op)	51.9	18.0	26.7	49.6	49.0	26.4	48.3	40.0	28.8	0.1	0.9
Extension (pre-op)	2.8	18.0	6.7	0.7	49.0	3.2	0.1	40.0	0.8	3.6	0.01
external rotation (pre-op)	10.8	18.0	9.1	7.5	49.0	7.4	9.8	40.0	8.8	1.5	0.2
Internal rotation (pre-op)	1.7	18.0	3.4	2.9	49.0	4.7	1.1	40.0	3.1	2.2	0.1

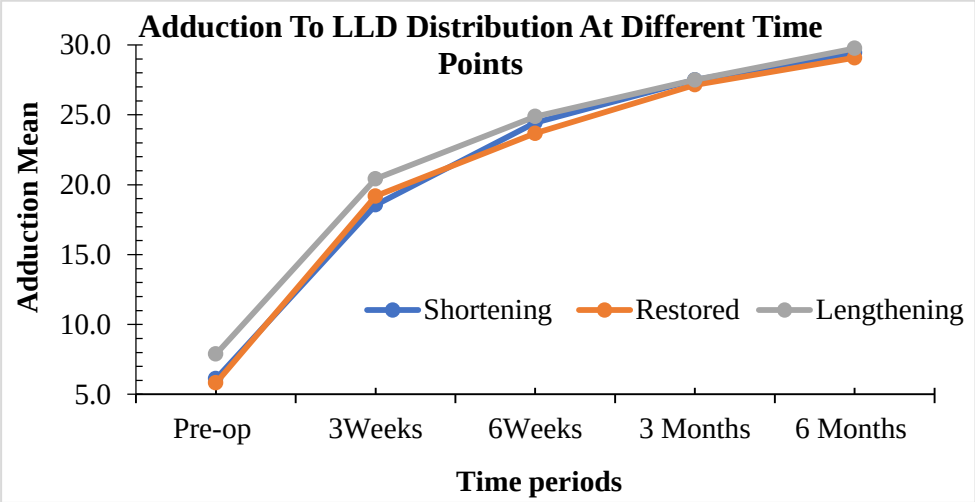
Adduction at 3 Weeks	18.6	18.0	7.9	19.2	49.0	7.0	20.4	40.0	7.8	0.5	0.6
Abduction at 3 Weeks	23.6	18.0	7.2	22.2	49.0	7.1	23.9	40.0	8.3	0.6	0.6
Flexion at 3 Weeks	53.6	18.0	21.5	58.2	49.0	20.0	59.8	40.0	22.1	0.5	0.6
Extension at 3 Weeks	6.9	18.0	3.9	7.0	49.0	4.4	7.4	40.0	3.4	0.1	0.9
External rotation at 3weeks	11.7	18.0	4.5	11.6	49.0	3.9	12.1	40.0	4.2	0.2	0.8
Internal rotation at 3 Weeks	6.9	18.0	5.5	8.2	49.0	4.6	8.9	40.0	4.5	1.1	0.4
Adduction at 6weeks	24.4	18.0	6.2	23.7	49.0	5.6	24.9	40.0	6.5	0.5	0.6
Abduction at 6 weeks	28.6	18.0	7.2	28.8	49.0	8.7	29.7	40.0	8.5	0.2	0.8
Flexion at 6 weeks	69.4	18.0	19.7	72.6	49.0	17.1	73.4	40.0	16.8	0.3	0.7
Extension at 6 weeks	11.4	18.0	4.1	11.7	49.0	3.9	11.9	40.0	3.5	0.1	0.9
External rotation at 6 weeks	15.0	18.0	3.8	13.9	49.0	4.1	14.1	40.0	4.2	0.5	0.6
Internal rotation at 6 weeks	13.1	18.0	3.9	12.6	49.0	4.1	12.9	40.0	3.9	0.1	0.9
Adduction at 3month	27.5	18.0	3.9	27.1	49.0	4.3	27.5	40.0	5.1	0.1	0.9
Abduction at 3months	31.1	18.0	6.5	32.5	49.0	7.3	33.3	40.0	7.2	0.6	0.6
Flexion at 3months	80.3	18.0	11.6	83.8	49.0	10.3	84.3	40.0	10.6	0.9	0.4
Extension at 3months	12.8	18.0	4.3	13.4	49.0	4.4	13.4	40.0	4.3	0.1	0.9
external rotation at 3months	16.4	18.0	3.8	15.3	49.0	3.6	15.9	40.0	3.7	0.6	0.5
Internal rotation at 3months	14.7	18.0	2.7	13.5	49.0	3.6	14.0	40.0	3.0	1.0	0.4
Adduction at 6months	29.4	18.0	1.6	29.1	49.0	3.3	29.8	40.0	3.9	0.4	0.7
Abduction at 6months	34.2	18.0	5.8	35.6	49.0	6.7	37.1	40.0	5.5	1.6	0.2
Flexion at 6 months	90.3	18.0	10.5	92.6	49.0	8.9	92.9	40.0	8.2	0.6	0.6
Extension at 6months	15.0	18.0	3.4	14.2	49.0	4.1	14.6	40.0	3.8	0.3	0.7
External rotation at 6months	16.7	18.0	3.4	15.9	49.0	3.5	17.0	40.0	3.4	1.1	0.3
Internal rotation at 6months	14.7	18.0	2.7	14.3	49.0	3.2	15.3	40.0	2.3	1.3	0.3

Notes:- HHS- Harris hip score ,M- Mean, SD- standard deviation, n- no of subjects

F-test to see the variation of ROM across LLD Groups was studied using F test and all the groups showed no variation with P>0.05 suggesting that there is no difference in ROM and HHS score across the three LLD groups thus the LLD between -20mm to +20mm has no influence on clinical as well as patient reported outcomes. Only in pre operative extension Range of motion there is variation amongst the LLD groups with P<0.05.

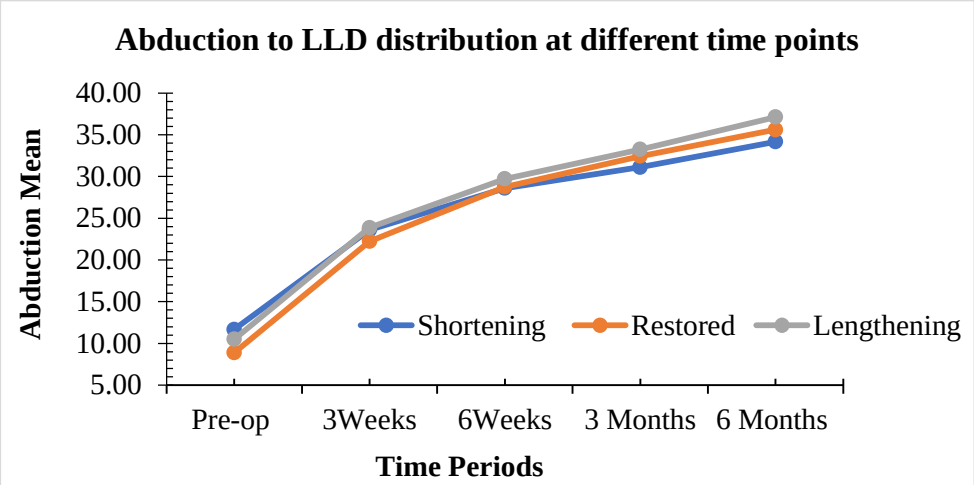
Figures for Intra group variation observed among the three LLD groups

Figure 31 A: comparison of Adduction Range of Motion at different time points to LLD groups using trendline.



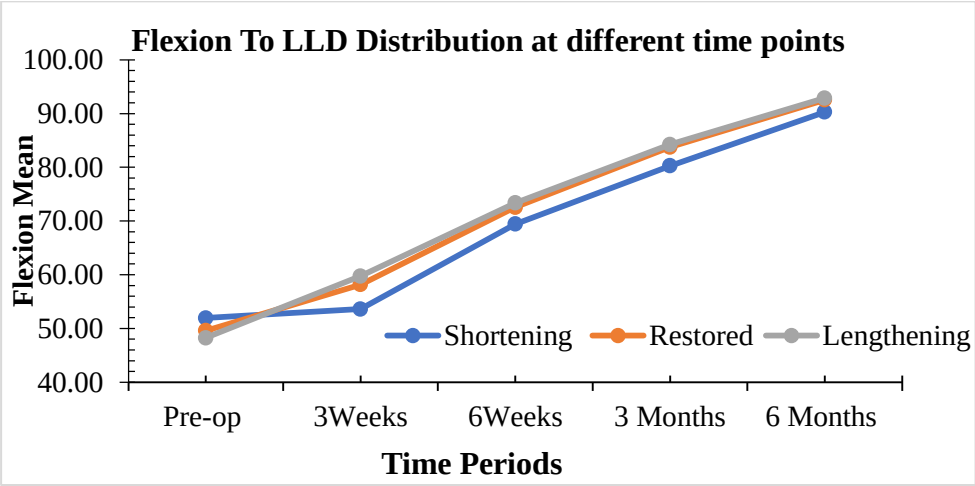
There is mild variation in between shortening, restored and lengthened groups from pre op to 3rd month but from 3rd month this variation is masked. As no effect of improvement is seen in adduction component, irrespective of shortening, lengthening & restored LLD groups(intra group) from 3rd month to 6th month follow up period interval. This graph suggests statistically non-significant variation (for intra LLD groups).

Figure 31 B: Comparison of Abduction Range of Motion at different time points with LLD groups.



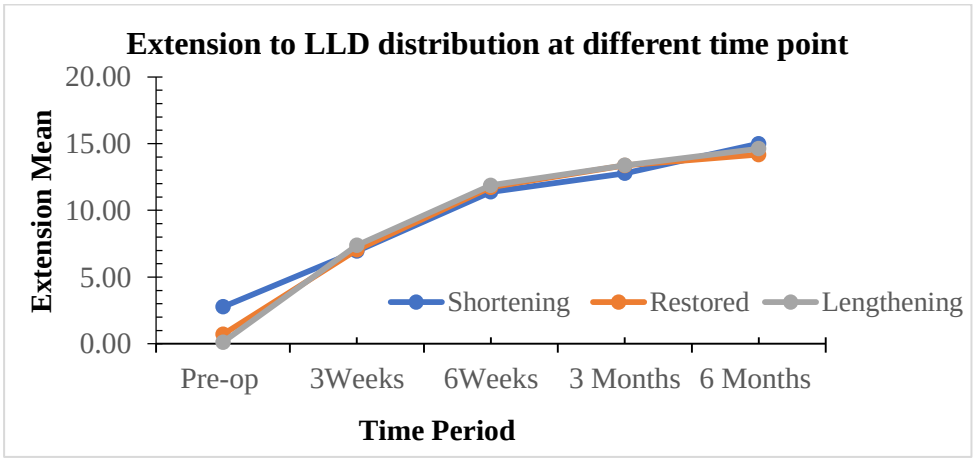
There is mild intra group variation observed between the LLD groups at each time interval when the effect of LLD groups was assessed with the improvement seen in the gained abduction component as a measure of functional outcome, despite of this observation this graph is also suggestive of statistically non-significant variation for these three LLD groups with respect to abduction component.

Figure 31 C: Improved flexion component relation at different time points with LLD groups.



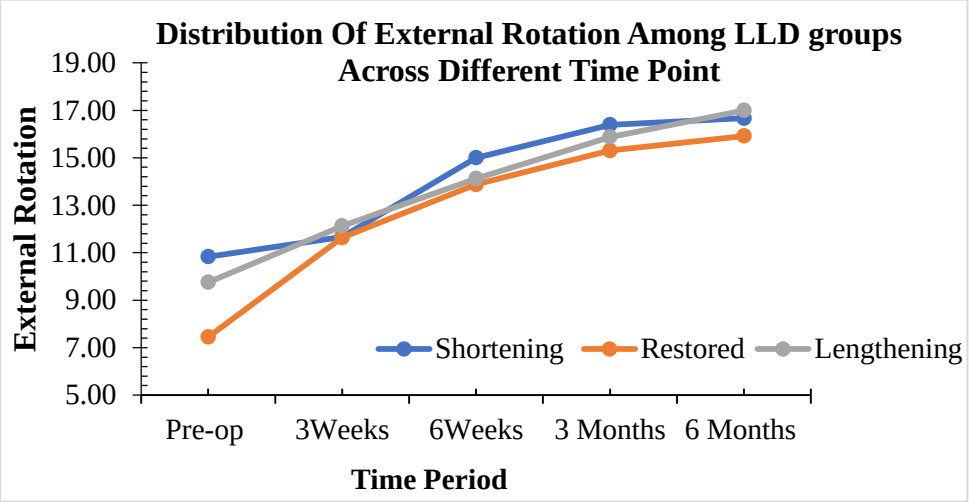
There is no variation in between restored and lengthening groups but shortening group varies from both the other groups (intra group variation observed among the tree LLD groups is statistically Non significant.

Figure 31 D: Distribution of Extension range of motion at different time points with LLD groups.



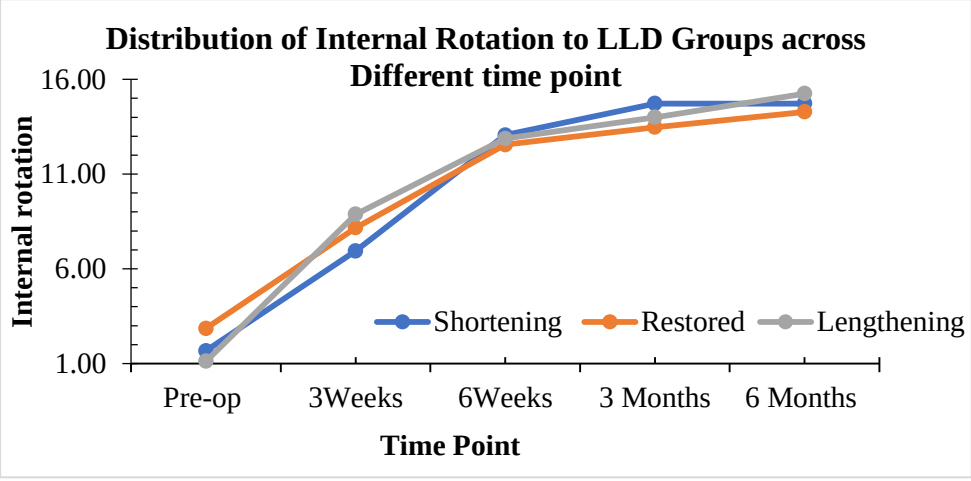
There is variation in between shortening, restored and lengthened groups from pre op to 3weeks and after 3 weeks the variation has masked.

Figure 31 E: Comparison of external rotation with LLD groups by Trendline



There is very mild variation in between shortening, restored and lengthened groups with respect to external rotation over the time period.

Figure 31 F: Comparison of internal rotation with LLD groups by Trendline at different time point.

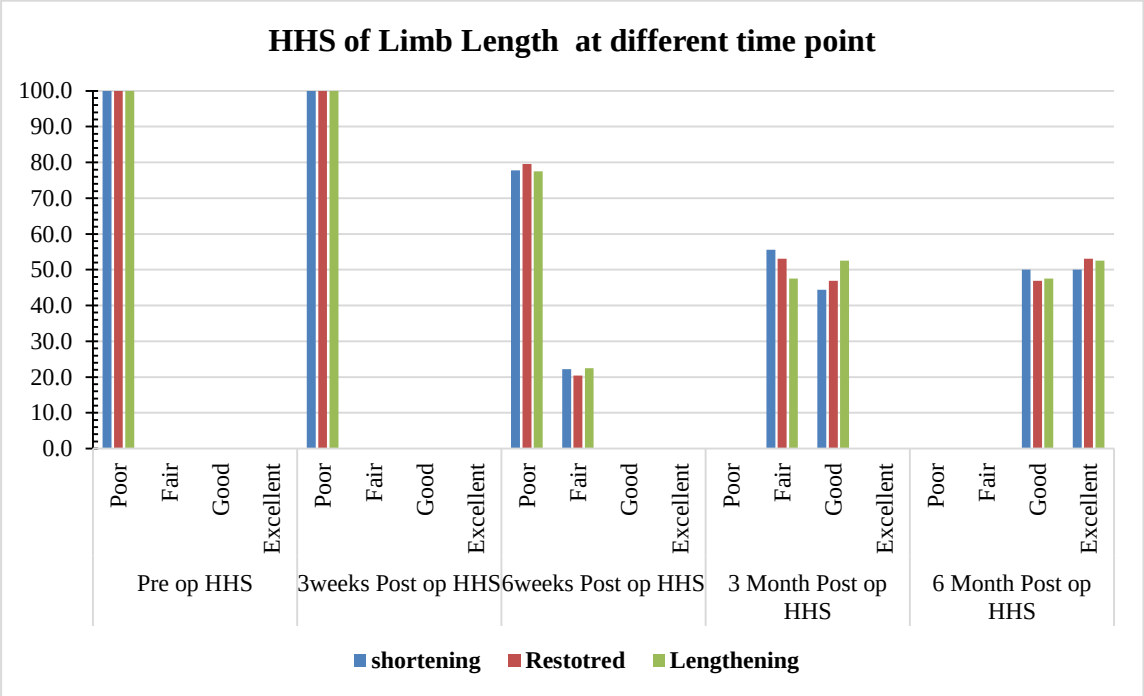


There is mild variation in between shortening, restored and lengthened groups but Variation is statistically non-significant.

Table 18: Distribution of HHS with LLD groups at different time point

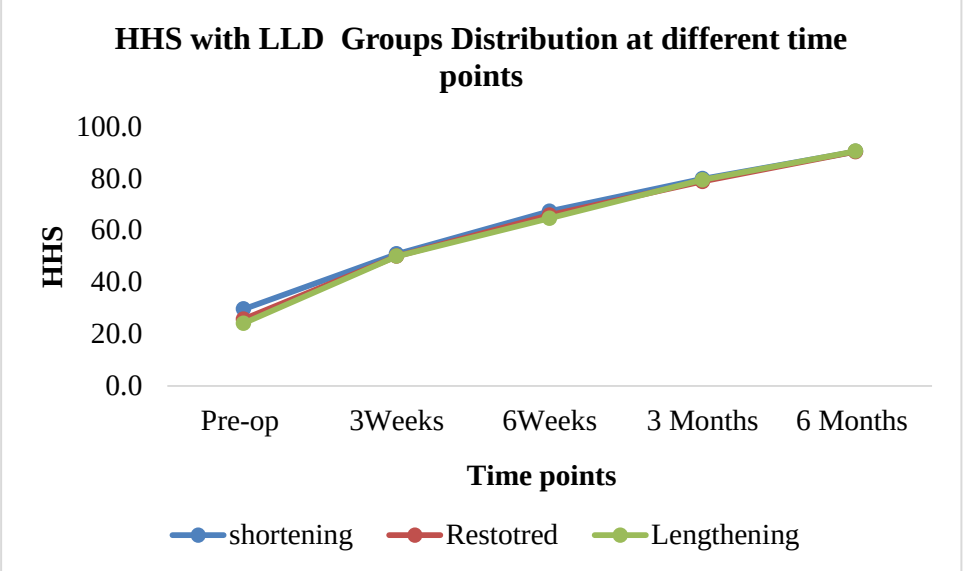
HHS		Limb Length		
		shortening	Restored	Lengthening
Pre op HHS	Poor	100.0	100.0	100.0
	Fair	0.0	0.0	0.0
	Good	0.0	0.0	0.0
	Excellent	0.0	0.0	0.0
3weeks Post op HHS	Poor	100.0	100.0	100.0
	Fair	0.0	0.0	0.0
	Good	0.0	0.0	0.0
	Excellent	0.0	0.0	0.0
6weeks Post op HHS	Poor	77.8	79.6	77.5
	Fair	22.2	20.4	22.5
	Good	0.0	0.0	0.0
	Excellent	0.0	0.0	0.0
3 Month Post op HHS	Poor	0.0	0.0	0.0
	Fair	55.6	53.1	47.5
	Good	44.4	46.9	52.5
	Excellent	0.0	0.0	0.0
6 Month Post op HHS	Poor	0.0	0.0	0.0
	Fair	0.0	0.0	0.0
	Good	50.0	46.9	47.5
	Excellent	50.0	53.1	52.5

Figure 32 A: Distribution of HHS with LLD groups at different time points



The table 16 and figure 32A both shows that there is mild difference in percentage of cases improved in three LLD groups over 6 months of follow up.

Figure 32 B: Comparison of HHS with LLD groups by Trendline at different time point.



There is negligible variation seen in shortening, restored and lengthening LLD groups with respect to mean HHS score at different time point.

5. DISCUSSION

The management of LLD in THA remains an orthopedic challenge. The primary reason for this difficulty lies in giving stable hip which is not overlengthened or optimized to its inherent biomechanics.

Any technique to optimize precise LLD must restore the anatomy & achieve a painless hip without gait disturbances, but the surgical results of arthroplasty have less meaning unless they are considered in the light of functional outcomes.

This prospective study was conducted with an aim to study the determinants responsible for LLD in a cohort of patients undergoing primary Total hip arthroplasty along with other factors aaffecting the change in LLD from preoperative to postoperative period.

This involved clinical & radiographic evaluation, subjective patient reported outcomes and assessment of change in LLD for follow up period of 6 months at a tertiary care hospital in north Karnataka.

Comparison of age and gender of previously published studies.

In the present study mean age was 52.5 years (range of 18 to 81 years) and a sample size of 107 patients, for different age-related conditions.Thus, present study might be focusing on a broader age range with a more diverse group of patients similar to the sample size in a study by **Ross Doehrmann DO et al.**[58] which had 145 patients & mean age of 59 years. The mean age of (52.5 years) is the lowest among all the studies compared, suggesting that the participants tend to be younger on average, while the **Gallo et al**[62]**.** study has the highest mean age of 62.9 years among the other

studies we compared, indicating that their sample may consist of older individuals similar to an other study by **Hardwick-Morris M et al**[56] with highest mean age of 69.6 years.

Ross Doehrmann DO et al.[58] study has a slightly lower mean age of 59.1 years compared to the **Gallo et al.**[62] study, but this difference is not substantial. In our study majority of patients (98%) were from 20-79 age group with standard deviation of 15.4 if range of 20 to 79 years was considered instead of 18 to 81 years & most of them had AVN indicating indirect relation of younger age in our study even though not statistically significant.

Table no 19: Comparison of Age-gender in LLD

Sl No.	Study	No of hips	Mean age (years)	Male %	Female %	Notes
1	A Moslemi et al[52]	266	65 ± 13.09(for traction table) 64.8 ± 14.01(for standard table)	116 m	150f	Standard table doesn't provide better control over leg length in THA for Direct Anterior Supine Approach (Our study used Lateral approach where traction table is not needed)
2	Gallo et al[62]	100	62.9 ± 11.2	-----	------	Radiological based study/suggests measurements using Lesser Trochanter as landmark prior to THA
3	Ross Doehrmann DO et al[58]	145 (104)	59.1 ± 11.1	34 m (36.9%)	70 f (63.1%)	They used Fluoroscopic Grid Technique to restore limb length and hip offset during Anterior approach for THA.
4	Hardwick-Morris M et al [56]	100 (93)	69.6 ± 9.4	43m (47%)	50 f (53%)	The conventional method of measuring leg length discrepancy (LLD) on an anteroposterior pelvic radiograph does not correlate well with long leg measurements, and may not provide a true appreciation of LLD. As such, there may be a need to reassess the ongoing use of this measurement of LLD.

5	Henry Dunn, Geoff Rohlfing et al[63] Mean LLD >1cm to >1.5cm	121	62.5 (range 32.6–87.2 yrs)	59 m (48.76%)	62 f (51.24%)	Retrospective review & comparison of anterior & anterolateral approaches in LLD.in overlay technique.
6	Charnley Low-Frictional Torque Arthroplasty of the Hip Practice and Results B.M. Wroblewski etal [64]	500	65 years (range 22–86)	---	----	Detailed book on large series of Charnley etal work quoted by wroblewskii et al[64]
7	Smolle et al Austria [65]	99	61 years	54% m	46% f	Early phase LLD is inaccurate
8	Ishan et al USA[66]	1.8million	65.98 (0.05)	1,239,107 m (43.65%)	1,599,635 (56.35%)	Epidemiological study of retrospective data analysis in THAs
9	Present study	107	52.5	64.5%	35.5%	

Gender:

In comparing the gender balance across the other studies, we observed variations in the representation of males and females within each sample. The present study has a higher representation of males (64.5%) compared to females (35.5%), indicating a male dominant sample with almost 1:3 ratio. In contrast, the studies by **Henry Dunn et al[63].** and **Ross Doehrmann DO et al[58]**. have a higher percentage of female participants, with gender ratios of 51.24% and 63.1%, respectively. While **Smolle et al[65]**.'s study, appears to have balanced representation of males and females, with a near-equal distribution. Regarding epidemiological statistical inference on larger study by **Ishan et al[66]** it was 43% males to 56 % females in a retrospective analysis of 18 lakh total hips excluding revisions. This study has gender pattern similar to **Wroblewski et al[64]** s comment on changing patterns of patient's genders a decade back, as gradual increase in males presenting for hip replacement in UK.in his book of **2013**.

Diagnosis(etiology) of previously published studies.

Patients who underwent THA in our study were divided into 6 categories of arthritis aetiology wise as follows 45.8 % (49 patients) had AVN, next leading cause was OA with 21.5 % (23 patients), 9.3% (10 patients) were post traumatic OA and patients having recent fractures of hip was noted in 13.1% (14 patients) and inflammatory arthropathy in 7.5% (8 patients), while DDH was noted in just 2.8 % (3 patients) in total of 107 patients.

Meanwhile, in a study by **Smolle M.A. et al[65]** in total of 99 patients diagnosis were OA in 95 patients (96.0%) & AVN in 4 patients (4.0%),in a study by **Kumar P**

et al[67] in total of 118 patients 50 patients were AVN,36 patients were of post traumatic OA, 17 patients were primary OA & 15 patients of inflammatory arthropathy, In a study by **Brown et al**[68] in total of 101 patients OA was in 51 patients inflammatory arthritis in 33 patients and 17 patients of recent hip fractures & post traumatic arthritis in 12 patients while AVN in 4 patients & DDH in 1 patient.

While Comparing the distribution of different etiologies of hip arthritis with other studies, Each study shows a different prevalence of hip arthritis. The present study and **Kumar P et al.**[67]'s study shows AVN being a leading cause in both studies. **Smolle M.A. et al**.[65]'s study is predominantly focused on OA as predominant diagnosis, and **Brown et al**.[68]'s study presents a more balanced representation across OA, inflammatory arthritis, and recent hip fractures.

The presence of post-traumatic OA and recent hip fractures varies across the studies, with a notable representation in the present study and **Brown et al**[68]**.'s study**. The prevalence of inflammatory arthropathy is also different across the studies.

DDH is less prevalent in all the studies. Its low prevalence might be due to its less frequent occurrence in the general population.

Total number of patients in the studies were comparable as they had a range from 99 to 118 patients. This factor allows for a relatively even comparison across the studies.Significant variations could be influenced by several factors, such as patient demographics, geographical location, and research objectives as this could affect the generalizability and clinical implications of the findings. AVN is the most common cause of disease affecting hip arthritis as a cause for THA.Our occurrence of AVN is consistent with comparison to other studies.

Involved Side wise Distribution of patients

In this study total 107 THA were done out of which 43 were left hip and 64 were right hips (there was no association noted with the side involved & LLD(Chi square-3.53,df-2,P value 0.188) similarly in study by Doehrmann et al , The study aimed to assess the accuracy of leg length and hip offset measurements using a fluoroscopic grid during anterior approach total hip arthroplasty. The study involved 107 total hip arthroplasty procedures, with a higher number of cases performed on the right hip (n=64) compared to the left hip (n=43), in study by **Rasheed et al**[69] , The study included 44 total hip arthroplasty procedures, with a higher frequency of cases performed on the left hip (57%) compared to the right hip (43%). The study focused on measuring and analysing the mean limb length discrepancy after total hip arthroplasty. The distribution of left and right hip cases in these studies is essential for understanding the representation of each hip in the research.

Surgical Approaches

By using only, the lateral approach in all 107 THAs and eliminating the comparison with the posterior and other approaches, the present study aimed to minimize the potential bias related to the surgical approaches and focus on the outcomes specific to the lateral approach. Suggestions by some authors[6] that the choice of surgical approach (lateral or posterior) did not have a significant impact on the clinical outcomes is not studied here. As studied by **Barber et al**[70] comparing two, the direct lateral and posterior approaches, were compared in patients who underwent primary total hip arthroplasty (THA) for osteoarthritis. The results of their study suggest that the particular surgical approach chosen (lateral or posterior) did not significantly affect the clinical outcomes seen in individuals having THA, all our 107

primary hips got operated with standard lateral surgical approach with hips dislocated in flexion abduction & external rotations after the capsulotomies in lateral decubitus positions irrespective of the deformity involved. For complex & difficult hips appropriate surgical measures like neckless insitu osteotomy & relevant surgical release were done.

Incidence:

Leg length discrepancy is a known complication following total hip arthroplasty, and its incidence can vary widely depending on the study and the surgical techniques used. Proper preoperative planning, accurate intraoperative assessment, and appropriate surgical techniques can help minimize the risk of leg length discrepancy after THA.in the present study the LLD was noted in 54 .2% post operatively and has not varied over 6 months of follow up. Study **by Desai et al[71]**: report that the incidence of leg length discrepancy after primary THA has been reported to range from 1% to 27%. This indicates that the occurrence of LLD can vary across different studies and patient populations. Study by **Ranawat et al[72]** report that functional leg length inequality has been noted to be transient (temporary) in nature in approximately 14% of patients who undergo THA. This suggests that in a subset of patients, there might be a temporary difference in leg length after the surgery, which may improve over time.

Distance from Kohler's line on Preop x-rays. (Protrusio acetabulum)

When preoperative distribution for protrusion acetabulii (distance from Kohler's line) was analysed,80 % of patients had no protrusion while in 20 % it was till +20mm this was due to One from DDH (out of 3 pts) Posttraumatic OA

(acetabular fracture) in 2 patients with 20mm Protrusion. These findings are consistent with study of **Van De Velde S, et al** [73] regarding aetiologies of Acetabular protrusions.

Patients hip Muscle wasting (atrophy)

All the studies, including ours, indicate that muscle wasting is a common issue in patients undergoing hip arthroplasty. Whether it's due to osteoarthritis or osteonecrosis, or similar aetiologies the hip and thigh muscles tend to become weaker and atrophic before surgery. **Shih et al[74].** study showed that all hip muscle groups were weaker in patients with osteoarthritic and osteonecrotic hips before surgery, especially in men with osteonecrosis. **Chou et al[75].** study noted that the peak muscle torque of affected hips was significantly lower than unaffected hips before two-incision total hip arthroplasty. While in a study by **Reardon et al.al[76]** 19 patients demonstrated significant atrophy of the ipsilateral quadriceps muscle. Our 107patients underwent post-operative rehabilitation and targeted hip muscle strengthening exercises as recommended on case basis for a period of 2 weeks to 3 months promoting better recovery and functional outcomes after hip arthroplasty, this also reflected in HHS scores which improved in the majority of patients at 3 months as in Fig.7 and Fig 30

Intra- Operative Factors

Femoral Head Component used, & head sizes in diameter of THA patients

Ceramic heads used were 42.99% in (46 hips) while in 57.01% patients i.e. 61 hips we used metal heads. The most commonly used 2 head sizes were 28mm & 32 mm in 100 patients (size range of 28mm to 36mm). 54.21% or 59 hips having 28mm

& in 38.32 % or in 41 hips 32mm was used, while in only 7 hips 36mm size was used. Poly thickness used was above 6 mm in all our implanted hips. None of the studied patients had dislocations and usual concerns of impingement & edge loading in relation to head sizes were not encountered in the short term follow up of 6 months. This result is consistent with studies published by **Georgois Tsikandylakis et al**[77] & study of **Burroughs BR etal**[78] about the recommendation for average use of 32mm femoral head in contemporary primary total hip arthroplasty with stability (Fig10 and Fig 11).

Head Size (in Neck Length-Offset Variation) of implants in THA.

As Limb length is directly influenced by size of neck length which is incorporated inside the head of a particular modular implant which is routinely used in modern hip arthroplasties, we divided them into sizes as neutral (or zero), plus sizes & minus ones to estimate this effect of offset & length. In our results, Head sizes with neck length (in plus) were 40.2% (n=43 hips) and head sizes with neck length in minus were noted in 25.2% (n=27hips) and head sizes with neck length 0 were 34.6 % (n=37hips). This was among the most influential determinant "plus sized neck lengths"_which appeared significant at P value of 0.011. by using multinomial regression model when other variables where compared (Fig 12).

Head & Acetabular Cup Size and reamer sizes utilized (shell size range 40mm to 60mm):

This size is decided as per what size cup is inserted as per manufacturers configurations of modularity for that company, but usual norm what surgeons follow

is one uses cup of 48 mm to 50 mm with head of 28-mm size only or 32-mm head articulates with shell sizes till 56 mm;

As denoted in a study by **Faldini et al[79] 2023,** post-surgical LLD above 3 cm may require revision & necessity to change the shell or components or if they are having malalignment cups need to be revised, such scenario was not encountered in our series of 107 hips as preoperative templating &anticipation of cup sizes had helped in execution of surgeries without such dreaded complications .90% of our cases had cup sizes between 46 and 54 mm, this being the most common size needed in our distribution of patients yet this may also reflect morphological aspect of acetabular sizes prevalent in our geographical demographics.

Similarly, cup reamer size used was in a range of 40 to 59mm mm with 48 to 52 mm as the most common sizes used, depending on bone quality & achieving punctate bleeds (Ranawats 3 blush sign for cementless cups) sequential reaming's were done.

In view of cup sizes at P value 0.309 (chi square value 2.35) we didn't have any statistical significance of cup size to be an influential variable of LLD in THR.

Cup version: (Range 15 to 30 degrees). The cup version varied between 15 degrees to 30 degrees with maximum version noted 20 degrees in among 62.62 % patients (n=67 cups). It has no association with LLD groups studied in this study value with P value at 0.695.

Post operative Variables

Cup Inclination: (on Post op X-rays; angle formed by the superolateral corner of Cup with inter tear drop line) (Range 37 degree to 55 degree) This variable has statistically significant association with LLD groups with P value at 0.03.

It appears that the distribution of cup inclinations differs significantly among the three (LLD) groups (shortening, restored, and lengthening) studied. Also, the distribution of LLD groups is not same across the cup inclination groups, suggesting that cup inclination angles may influence the LLD condition in the study population. Out of 107 hips, 101 Patients were restored at cup inclinations of 45 to 55 degrees. Which is consistent with average norm of THA literature[6]. As stated, despite being influential determinant of LLD concretely suggesting at which cup inclination angle it affects LLD will need large sample sizes in the cup inclination groups (Fig 18).

Stem inclination: Is an independent influential variable.

Analysis suggested influence of stem inclination on shortening group for valgus stems, considering a p-value of 0.03 has strong association. Specifically, hips with valgus stems are about 22.69 times more likely to be in the shortened LLD group compared to hips with neutral stems. Given that there are 7 valgus stems in a sample of 107 hips with 81 neutral stems, this indicates a notable influence of stem inclination on the limb shortening group, despite of relatively small number of valgus stems in the sample. Opposite to this, in the lengthened group of 40 hips Stem inclination is very less influencing factor on LLD as valgus and varus group stems had 4 times higher lengthening cases than neutral group.(Fig 20 & Table 10)

Stability of HIP in LLD

LLD is prevalent after THA, most often overlengthening is more observed and less tolerated than shortening phenomenon as noted in **Desai et al [71]2013.** Since achieving stability takes priority over achieving equal leg length, as well as due to the intraoperative difficulty of correct leg length assessment, both conditions are often caused by THA. In our study total 18 hips had shortening in post operative THA, but increase in length as compared to their preoperative shortenings. While none of the patients suffered dislocations till 6 month follow ups, we had better results regarding stability of all the 107 primary hips. We could not identify a device or technique which will tell precise number of abductor muscle tension potentially needed to say that a particular hip has sufficient hip tension. Intraoperatively stability assessment is still surgeon dependent variable & can have bias for increased or decreased LLD if surgeon feels inadequate abductor muscle tension while reduction of final hip post implantation or while assessing stability tests like shuck test.[6,10,19]

Post operative complications:

101 Patients did not develope new complication than the preexisting comorbidities. Other major complication after THA noted was CVA in 3.74% cases which is 4 out of 107 cases. All of the patients had transient Cerebrovascular event in 2nd month to 3 rd. month of surgery while other complication noted was development of hypertension in 2 cases. None of the patients had severe morbidity owing to CVA & all patients remained ambulatory after neurologists' conservative treatments. This complication could be owing to non-compliance of anti-thrombotic oral drugs intake neglected at home & associated age related or lifestyle related risks (obesity, DM,

tobacco, etc) & other risks related to pre-existing comorbidities in this 4 CVA patients.

Weight Bearing status:

All the Patients used walker in immediate post operative periods with 39 patients ambulated full weight bearing & remaining 68 patients did partial (63.5%). weaning of walker was done in 3 weeks to 3 months depending on patient tolerance & individual assessment. None of the patients had complications like stem subsidence or falls & this variable had no influence on LLD statuses. None had post op dislocations.

Post operative wound condition:

This determinant had no effect on LLD in our study, wound was healed in 89.72% (96 hips) in 2 weeks and 10.28% (11 hips) it was dehisced, with mild ulcerations causing delay for 3 weeks and one patient among them had nutritional hypoalbuminemia which corrected with supplements. Complete wound healing and no signs of infection was observed in 3 weeks for all 107 patients included in the study.

Patients Number of days in Hospital Stay. (Range 5 to 15 days)

Our study reported longer hospital stays on average (10 days) compared to the initial experience of the Berger et al. study using minimally invasive two-incision THA (1.5 days for the first 12 patients). The reduced hospital stays in the **Berger et al[80].** study can be attributed to the less invasive surgical approach and implementation of a same-day discharge pathway. Our study & hospital do not follow above discharge criteria's, rather our department also having charity type of hospital & patients from all socio-economic strata were included, moreover hospital stay duration can be

influenced by various factors, including the surgical approach, patient characteristics, severity of deformity & previous ambulatory status, post-operative protocols, and any complications that may arise. As this was not part of study design, analysis of these factors on LLD in THA was not done in detail. But we had 39.25% (42 patients) discharged in 5 days. Also some of the patients opted voluntarily to overstay for 2 weeks as some expected to get discharged at stich removals only. This aspect of patient psychology couldn't be explained in our study.

LLD Limb length Discrepancy

Methodology:

Anatomical Landmarks:

Tear drop was used as anatomical landmarks for all patients in our study. As they were referenced using inter tear drop lines on AP view Xray of both hips & LLD differences from lesser trochanter of the involved hip before surgery & after prosthesis implantation on post operative Xrays.This change was noted.

Most of the studies involving LLD has supported the use of any prominent radiological anatomical landmarks like Tear drop, tip of Greater trochanter, lower & upper SI joint & iliac crest, while some studies suggested use of Tear drop & we also used this point as it is closest available landmark intraarticularly which won't alter before & after surgery, This tear drop is also near the cup implantation & readily available near to the TAL-transverse acetabular ligament or icg-infracotylyoid groove, whereas other anatomical landmarks like illioschial/(Kohler's) line are violated by over-reaming & ballooned in acetabular protrusions. While SI joint & iliac crests or ischial landmarks are placed not only away from the native hip (coxa) but all these may get influenced with soft tissue contractures & extraarticular causes of pelvic

obliquity which gets corrected over time[7,10].

Similarly in studies of adolescents related to LLD in hips, some authors have used articular-trochanteric distances which we did not use, as our study had inclusion criteria for adult hips above 18 years & implanted prosthesis could hamper(alter) the real intra articular radiological marks owing to reamed articulation while performing cup side reaming & metal or cemented cup itself.

Thus, tear drop & inter tear drop line was chosen as most reliable referenced anatomical landmark for all radiological calculations of LLD as it has a configuration which gets less affected even in pelvic rotations.

We also had only 3 hips affected with DDH OA- with Crowe Type 1 as cause of arthritis secondary to any childhood hip dysplasia & none had radiologically altered tear drops in our operated hips but anteversion associated with capsular contractures were affected in our small series of these 3 dysplastic hips. This occurrence of a smaller number of DDH cases may be due to less incidence & prevalence observed or studied in this part of Karnataka & in India as compare to other parts of the world suggested by **Randall[81] et al** in relation to DDH as cause of THA & arthritis. None of our patients had dislocation in 6 months follow ups. Intraoperatively LLD change was noted as per Ranawats technique. More severe forms of neglected OA of DDH(Crowe type 3 or 4)did not form our cohort of hips probably owing to lack of such patients demographically in this part of Karnataka.

As LLD intraoperatively was never corrected by measuring contralateral hips, unless one uses or intend to use intraoperative fluoroscopic measurements, hence True LLD is what one should consider in restoring, measuring & predicting or for defining

LLD as per LLD of that native hip, avoiding contralateral hip adducted & pelvic obliquity in lateral decubitus positioning seen on OT tables.

Classification (LLD)

The LLD was classified into several groups based on the magnitude of shortening or lengthening observed. Other important aspect was to consider Pre - Intra and post- operative Limb length Discrepancy.

Regarding Definition of LLD Some authors **Faldini etal[79] 2023** have suggested possible definition as as mild less than 1 cm, moderate from 1 to 2 cm & severe 2 or more forms but it has no statistical backing & fails to highlight hips which are restored to zero LLD which did not suit the available literature for much bigger topics like LLD as: Following possibilities are & may be encountered by each & every hip surgeon intraoperatively theoretically & practically in relation to LLD during THA:

1. Attempt of pre-op shortening to persistence of that shortening (No change in pre-shortening) Eg: HHC-High hip centre type of THA surgery
2. Attempt of pre-op shortening but more shortening (severe unwanted scenario)
3. Attempt of pre-op shortening to no shortening & no lengthening (No Change-**Restoration**)
4. Attempt of pre-op shortening to lengthening (increase in **Plus**)
5. Attempt of pre-op lengthening to post op more lengthening (increase in **Plus**)
6. Attempt of pre-op lengthening to post op lengthening (increase in **Plus**)
7. Attempt of pre-op lengthening to post op more shortening (severe unwanted scenario)

8. Attempt of pre-op lengthening to post-op no shortening/no lengthening (**Restoration**)
9. Attempt of pre-op No change (No pre LLD) to post op no change (No Change-**Restoration**)
10. Attempt of pre-op No change (No pre LLD) to post op lengthening (increase in **Plus**)
11. Attempt of pre-op No change (No pre LLD) to post op shortening (**Minus** unwanted scenario)

Hence, we classified LLD as restored LLD group termed as no change LLD group: Shortened group as **M**inus LLD & Lengthened group as **P**lus LLD groups for ease of analysis. Which were further divided as three sub groups respectively.

[**M1** is -1 to -11 mm] [**M2** is -12 to -24mm] [**M3** is -24mm & more shortening]

[P1 is +1 to +11 mm] [**P2** is +12 to +24mm] **[P3** is +24mm & more lengthening]

The minus sign of the LLD can't be neglected while grouping them, as the determinants of shortening (LLD in minus) are varying in comparison to the lengthening (LLD in plus) thus indicating them as different. Many studies have classified LLD without considering the minus sign

For the Preop LLD group. Shortening was observed in a range of -40mm to -1mm in 89.7% of hips ,while in 10.3% (or 11 hips) they had no LLD preoperatively.

Note: we didn't observe any preoperative lengthening in any of the subjects included in the study.

Intraoperative determination of LLD (Range 0 to 42mm).

Change in length intraoperatively was measured by Ranawats Steinmann pin technique. We observed during surgery, lengthening was resulted in 95.3% or 102 hips similar to 100 hips studied by Ranawat et al who had mean LLD of 6.09 in a range of 0 to 15mm & our study had mean LLD of 15.7mm in a range of 0 to 42 mm intraoperatively, this variation is because of preop range in Ranawat study with range of -24 mm to +5mm.Likewise, **Turula et al**[82] had mean LLD of above 5mm but without intraoperative measurements Other authors like **Jasty etal**[46] had 2.6 mm to 9mm mean LLD using pin technique or **Woolson et al**[46]

Had just 1mm mean in post op from mean of 2.9 mm in preop suggesting such lower occurrence of mean as their patients had almost no deformities or normal bone anatomy as stated in them studies.

(Note: As one to 2 mm possibility of error could be observed owing to size of the pin diameter, we measured at the centre of this thickness of the pin)

On Comparison of LLD from Pre op to Intra Op by using t-test at with p value <0.001

We aimed to evaluate Limb Length Discrepancy (LLD) before and after total hip arthroplasty (THA). As the mean true LLD in preop was 13.98 mm, while the mean LLD after intraoperative correction was 15.54 mm. The difference in LLD from preoperative to intraoperative was found to be highly significant ($p < 0.001$) based on t-test statistics. Though the groups and through the means we can say that significant correction (15.54mm) was done intraoperatively.

Comparison of LLD from Pre-Op to Post Op Day (Range -4mm to +20 mm)

We did analysis in 3 groups using t test statistics and shows that there is significant difference in means of all three LLD groups with $p<0.001$.

This suggests that the surgery successfully corrected the limb length discrepancy in the shortening group, leading to a significant reduction in LLD after THA. The percentage of patients experiencing shortening decreased from 89.7% pre-operatively to 16.8% post-operatively & also successfully restored LLD in a significantly increasing proportion of patients within the restored/No change group from 10.3% in pre-op to 45.8% in post-operatively. We had no lengthened patients in the 107 hips preoperatively, For the studied lengthened group the increase in LLD post-operatively suggests that the surgery might have inadvertently resulted in a lengthening effect for this group .

Comparison of post operative LLD at different Time Point (follow ups)

Change in LLD post operatively over every follow up was assessed through f test and the f- value came to be 0 hence p value >0.05 which is non-significant.

As our study assessed LLD at various time points post-THA, focusing on True LLD radiologically including post-op day, 14-21 days, 6 weeks, 3 months, and 6 months. The mean LLD varied But Xray wise there was no change in true LLD Post operatively over different time points. Also no stem subsidence & component migration type of complications encountered. In contrast, studies by **Clark et al[83]., Tamon Kabata et al[84].**, and **A. Konyves et al[85]**. reported varying ranges of LLD post-THA, suggesting that achieving an exact limb length equality after THA might not always be possible. However, Clark et al. did emphasize waiting for 6 months

post-THA for potential resolution of LLD, a recommendation that aligns with our study's implication that LLD can potentially be resolved post-operatively. Comparatively, the study by **Moritz M et al.**[86] emphasizes that both hip offset reconstruction and leg length difference significantly correlates with HHS (Harris Hip Score) similar improvements is shown in our study as discussed in offset restoration through influential variable like femoral head or Head neck length modularity of implants in 42.2% of the hips.

Similarly, the study by **Maria Anna Smolle et al.**[65] also recognizes the inaccuracy of leg length measurements in the early postoperative phase, highlighting the importance of careful monitoring and longer-term follow-ups, ours was done for 6 months. It is important to understand that while some patients in our study experienced lengthening post-THA, others achieved limb length restoration, and some even experienced a reduction in shortening by restoration. Author **John M. Redmond et al**[87]. asserts that experience doesn't seem to significantly influence acetabular inclination, anteversion, or LLD, thereby indicating the complex nature of managing LLD, hence HHS scores were studied to know overall outcome of LLD in post op follow ups.

Shortened LLD group /Lengthened LLD group

Most influential determinant of LLD in THA are

1) Shortening: - Age, Diagnosis, Comorbidity, Head sizes variation, Stem inclination

2) Lengthening: - Age, Comorbidity, Head sizes variation

Regarding Gender: this has very less influence on LLD. Among females lengthening cases were higher than male but not significant. In the associated Comorbidity groups of HDT (Hypertension/diabetes/Thyroid diseases) and other groups have 3 times higher chances of developing LLD in comparison with no comorbidity groups.

Perception of LLD:

The book adult hip emphasizes on the necessity of discussing since the preoperative planning period of THA about patients' perception not only for LLD but other parameters like pain or any arising complications. Since aspect of perception involves consideration of the fact of functional LLD & its effect or the influence of extra articular structures on patients' perception This study was not able to concretely derive individual patients' perception factor in relation to LLD, henceforth understanding at what threshold perception of LLD becomes clinically significant was not reached.

But, patient perception of LLD was emphasized in the study by **A. Konyves et al**[85]. In their study, they found that the mean perceived LLD at final follow-up was 1.0 ± 0.9 cm, significantly reduced from the preoperative value of 7.7 ± 2.6 cm ($P < .05$). This indicates that even though the actual true LLD measured postoperatively was 0.7 ± 0.8 cm, patients perceived it to be significantly less than what it was before the surgery. and this study suggests that patient perception of LLD can be reduced with the optimal placement of the femoral component which was achieved in 75.70% hips with neutral inclination & accurate femoral component placement in our 107 hips.

Clinical Improvement in ROM (range of motion) at different time points.

The comparison of ROM – Abduction, adduction, flexion, extension, internal rotation and external rotation were studied extensively, all independently at different time point analysis was done using t -test statistics and has come significant with p value <0.001, indicating improvement in ROM over different time point from pre-operation to post operative and 6 months after operation.

This is suggestive of no effect of presence of lengthening for the given mean LLD of 15,7mm observed in the studied hips.

There was no intra group variation seen between 3 categorized (viz shortening, restored & lengthened) LLD groups with respect to improvements seen in ROM and HHS scores at different time points. This result is consistent with the literature as quoted in the book Adult hip[6]. But when we studied our study with **Azizan et al[88],** reported that the ROM for the hip joint in the frontal plane showed significance at a minimum LLD level of 2.5 cm which is higher LLD than in the present study. They found that the mean ROM for the hip joint in the frontal plane for the short leg was slightly higher than that of the long leg at this LLD level. However, as the LLD level increased to 2.0 cm, the mean ROM in the long leg became higher than the short leg, and at 3.5 cm LLD, the long leg showed even higher ROM. This indicates a significant difference in ROM between the short and long legs. Thus, the ROM will be affected by LLD if the LLD is more than 2.0 cm and will affect significantly if LLD is more than 3.5 cm. (in our study maximum LLD was 2cm).

HHS Score at different Time Point Using Paired t-Test

In our study, the Harris Hip Score (HHS) was used as an outcome measure to assess the functional outcomes and improvement after total hip arthroplasty (THA) in patients with different hip conditions. When we compared our results with a study by **Taunton et al**[89] which was a prospective, randomized clinical trial, their results showed a trend toward faster functional recovery, as indicated by the improvement in HHS scores over time. Similar to our study, their HHS scores increased from the pre-operative baseline of 48.2-52.1 to 90.3-90.1 at 6 months post-op.

Similarly in a study by **Stibolt RD Jr et al**[90] for posttraumatic osteoarthritis following acetabular fracture: A systematic review of characteristics, outcomes, and complications which included 10 studies with a total of 448 patients. Their study also found a significant improvement in HHS scores but after a delayed THA. Their preoperative HHS scores were low (41.5), suggesting that patients had significant impairment in daily functioning prior to seeking THA. Their postoperative HHS scores improved to 87.6, indicating a substantial improvement in functional outcomes after THA.

In a study by **Michael R Whitehouse et al**[91] on patient satisfaction and functional outcomes in 191 patients they had cases 8.9% experienced as shortening, 0.5% had no LLD, and 90.6% had lengthening. The LLD was further categorized as follows: 21.5% had an LLD of more than 10 mm, 37.1% had an LLD of 5-10 mm, and 40.9% had an LLD of 0-5 mm.

Their study found no significant difference in patient-reported outcome measures (PROMs) based on the LLD experienced by the patients.

Their study reported that the leg length discrepancy following total hip arthroplasty was not correlated with Hip Scores. This implies that the variation in leg length did not have a noticeable impact on the improvement in PROM scores over the 6-month follow-up period in their study. But in our study, postoperative leg length changes were observed in both directions. Some patients experienced shortening, with a range of -14mm to -1mm in 18 hips, while others had lengthening, with a range of 1 to 20mm in 40 hips. The lack of significant correlation between LLD and functional outcomes suggests that achieving exact limb length equality might not always be necessary for successful patient outcomes. Regarding functional outcomes goal of this study was to evaluate the impact of a minor but significant complication, such as LLD after THA, utilising a prospective study design and HHS.

Overall, all majority of studies including ours demonstrated significant improvements in PROMs or HHS scores after THA over 6 months. Our interpretations indicate with proper preoperative anticipation of determinants of LLD postoperative LLD could be minimized to acceptable levels. While hip deformity with more comorbidities is more prone to changes in LLD. LLD from 20mm(lengthening) to -14mm (shortening) is tolerable and has no adverse effect on patients' outcomes moreover as observed in 6 months follow up HHS scores, we may conclude that patients having LLD in this range after THA can have excellent outcome after 6 months. There was no intra group variation seen between 3 categorized (viz shortening, restored & lengthened) LLD groups with respect to improvements seen in ROM and HHS scores at different time points, but minimum 3 months to 6 months follow up is essential.

6. SUMMARY

This study is about primary THA & knowing importance of LLD in a cohort of 107 Total Hip Arthroplasty patients. A successful hip surgery aims to restore joint motion and function, relieve pain, and improve the overall quality of life for patients. However, like any surgical procedure, THA comes with potential complications which can be divided into general and procedure-specific categories.

One of the common complications of THA is Leg Length Discrepancy (LLD), where the paired lower extremity limbs have noticeably unequal lengths. LLD can lead to abnormal gait, lower back pain, and reduced functional outcomes, causing patient to be unhappy. Preoperative assessment and accurate measurement of true and apparent leg lengths are essential to determine the extent of LLD and plan the surgery accordingly.

Similarly current literature being unconclusive about multiple terminologies used in context of LLD and the prevailing variability in techniques described to understand measurements of LLD including its reporting variability has kept the topic inconclusive one thing is confirmed that it exists before surgery, alters intraoperatively & manifests differently postoperatively.

Achieving equalization of limb length after THA is challenging, and a small disparity may still cause dissatisfaction in some patients. The factors influencing LLD, both preoperative, intraoperative, and postoperative, are not thoroughly studied with substantial sample sizes. This study aims to explore and understand the determinants affecting LLD and the impact of postoperative LLD on overall THA outcomes.

In conclusion, the study conducted focuses on investigating the factors influencing LLD after THA and how it may affect patient outcomes. By analysing a comprehensive range of factors, before the surgeries then intraoperatively & also includes surgeons' perspective & clinical methods along with radiological measurements & other implant variables. Thus, this study aims to contribute valuable insights to improve the success of THA surgeries and patient satisfaction.

7. CONCLUSION

- The determinants of LLD are age, aetiology (diagnosis), comorbidity, & implant variables like head sizes (in variation of neck offset), cup size and stem inclinations.
- There was no intra group variation seen between 3 categorized (viz shortening, restored & lengthened) LLD groups with respect to improvements seen in ROM and HHS scores at different time points. So LLD in range of -14mm to +20mm, after THA can have excellent outcome after 6 months.
- LLD in a range of -14 mm to + 20mm is tolerable and has no adverse effect on patients undergoing primary THA.
- The thresh hold at which LLD can become clinically significant is more than -14 to 20 mm.
- Excellent outcome of primary THA can be observed from at 6 months in the post-surgical follow up of, this improvement can be anticipated from the beginning of 3^{rd} or 4^{th} month after surgery in patients with LLD having mean of 1.8 mm.
- None of the patients underwent hip revision surgery for LLD or any causes of back pain/disatisfaction in the follow up period of 6 months concluding the safety of -14mm to +20mm range for LLD in primary total hip arthroplasty surgery.

7.1 FUTURE SCOPE

- Long term follow up studies in Indian scenarios are essential as having an artificial implant in vivo will have consequences, knowing the effects in south Asian patients is highly needed.
- Hip biomechanics has been studied thoroughly over a century, but abductor mechanism tension & its precise role intraoperatively under the influence of intra operative anesthetic muscle relaxing effect on stability & its correlation with LLD should be accounted or measured in research dedicated to this aspect.
- Influence of intraarticular effect of operated hip & LLD on extraarticular bony structures like lumbosacral spine, knees, contralateral hip & gait through dedicated gait labs may be studied to derive precise effects & overcome lacunas or biases which happen through human errors.
- Resected & decapitated diseased femoral heads & arthritic hips could be studied by histopathopathologists for better understanding of disease etiopathogenesis especially in the wake of AVN of hips encountered in the younger age groups.
- Similar or better studies in multiple centers could be initiated with larger sample size to generate data specific to Indian hips which can through light on morphological anatomy which may in turn help design implants specific to our socio-economic needs, as current Hip designs restrict patients from sitting cross legs /squatting in fear of edge loading & early implant failures, as lifestyle of Asians is different from westerners.

- Novel Classification for LLD in hips with a universal nomenclature along with & HIP scoring system could be designed for future research & practical applications.
- With increasing number of occurrence of Hip disease burden & number of Hip arthroplasties, establishing registry at the level of districts could generate meaningful data on the long term behavior & survivorships of bearings & implants in Indian contexts.

7.2 RECOMMENDATIONS

1. Surgeons anticipating optimized functional outcome for patients undergoing THA must consider preop assessment & documentation of LLD both clinically & radiologically.
2. Surgeons need to be more cautious & anticipate patients with more comorbidities & having age less than 40 years as they are more prone to unequal leg lengths (LLD) after THA.
3. Young Patients with hip AVN arthritis having mild type of LLD are less prone to non-restoration of optimal or equal lengths, hence their hips need to be precisely restored without any LLD.
4. The significant difference in LLD pre- and intraoperatively highlights the importance of precise surgical techniques in achieving the desired limb length. So orthopaedic surgeons should be attentive to intraoperative measurements and make necessary adjustments to ensure accurate correction. Intraoperative Ranawats Steinman pin technique is recommended for all THA patients for future study & measurements & restoration of LLD.
5. Most of the functional and clinical outcomes showed continued improvement between the three- and six-weeks periods and between the three-month and half year periods in the present study, suggesting that 6 months of follow-up is necessary for studies involving THA & LLD.
6. Much more important than the restoration of length, is the restoration of joints movements, as this will help the patient get hips painless joint function, but this restoration need to be in a range of minus 14mm to plus 20mm in regard to LLD.

7. It is important to acknowledge that while some patients in our study experienced lengthening post-THA, others achieved limb length restoration, and some even experienced a reduction in shortening. Hence, further research and longer-term follow-up studies are needed to establish definitive protocols for managing LLD effectively in THA.

7.3 LIMITATIONS

1. Though based on the multivariable multinomial logistic regression model chi square is 0.0158, which is less than 0.2, and with p <0.01, the overall model is significant. With sensitivity and specificity around 60 to 80%. But due to the sample size, not all the variables studied in the model showed significant influence. It is important to have a sufficient sample size for each group of variables. With a sample size of 107, statistical tests could not identify important relationships with strong statistical significance, pertaining to each aetiology like AVN/trauma/RA etc.
2. The surgical approach used was only lateral, so the influence of the approach couldn't be studied.
3. Since the COVID pandemic affected the study partially, attrition in participants & drop out during 2020 needed extra duration for the commencement of study.
4. We could not identify a device or technique which will tell precise number of abductor muscle tension potentially needed to say that a particular hip has sufficient hip tension in the muscles & this is still individual surgeons' assessment for hip stability when it comes to particular specific tension felt. Intraoperative measurement of abduction muscle tension irrespective of influence of anaesthetic effect in patients undergoing THA is a potential area for research yet a surgeon's limitation.
5. As only 35% women participants were involved /observed, multicentric study may overcome this effect.

6. With recent advances in robotic & navigated hip arthroplasties, comparative studies with randomisation & their association could bring more precise results.

8. BIBLIOGRAPHY

1. Bota NC, Nistor DV, Caterev S, Todor A. Historical overview of hip arthroplasty: From humble beginnings to a high-tech future. Orthopedic Reviews. 2021 Mar 3;13(1).
2. Charnley J. Low friction arthroplasty of the hip: theory and practice. Springer Science & Business Media; 2012 Dec 6.
3. Mayer M, Naylor J, Harris I, Badge H, Adie S, Mills K, Descallar J. Evidence base and practice variation in acute care processes for knee and hip arthroplasty surgeries. PLoS One. 2017 Jul 19;12(7):e0180090.
4. Husted H. Fast-track hip and knee arthroplasty: clinical and organizational aspects. Acta Orthopaedica. 2012 Oct 1;83(sup346):1-39.
5. Learmonth ID, Young C, Rorabeck C. The operation of the century: total hip replacement. The Lancet. 2007 Oct 27;370(9597):1508-19.
6. Rosenberg AG, Rubash HE, Clohisy J, Beaule P, DellaValle C. The adult hip: hip arthroplasty surgery. Lippincott Williams & Wilkins; 2015 Oct 13.
7. Malviya A, Abdul N, Khanduja V. Outcomes following total hip arthroplasty: a review of the registry data. Indian Journal of Orthopaedics. 2017 Aug;51:405-13
8. Krenn V, Morawietz L, Perino G, Kienapfel H, Ascherl R, Hassenpflug GJ, Thomsen M, Thomas P, Huber M, Kendoff D, Baumhoer D. Revised histopathological consensus classification of joint implant related pathology. Pathology-Research and Practice. 2014 Dec 1;210(12):779-86.
9. Gallo J, Gibon E, Goodman SB. Implants for joint replacement of the hip and knee. InMaterials for Bone Disorders 2017 Jan 1 (pp. 119-196). Academic Press.

10. Chapman MW, James MA, editors. Chapman's Comprehensive Orthopaedic Surgery: Five Volume Set. Jaypee Brothers Medical Publishers; 2019 Jan 31.

11. Kurtz SM, Ong KL, Lau E, Widmer M, Maravic M, Gómez-Barrena E, de Fátima de Pina M, Manno V, Torre M, Walter WL, de Steiger R. International survey of primary and revision total knee replacement. International orthopaedics. 2011 Dec;35:1783-9.

12. Abouelela A, Mubark I, Nagy M, Hind J, Jayakumar N, Ashwood N, Bindi F. Limb Length Inequality in Patients After Primary Total Hip Arthroplasty: Analysis of Radiological Assessment and Influencing Risk Factors Based on a District General Hospital Experience of 338 Cases. Cureus. 2021 Nov 29;13(11)..

13. Shiramizu K, Naito M, Shitama T, Nakamura Y, Shitama H. L-shaped caliper for limb length measurement during total hip arthroplasty. The Journal of Bone & Joint Surgery British Volume. 2004 Sep 1;86(7):966-9.

14. Dinkarbhai PU. A Study of Functional Outcome of Uncemented Total Hip Arthroplasty in Degenerative Hip Diseases (Doctoral dissertation, Rajiv Gandhi University of Health Sciences (India)) 2020.

15. Paley D, Chong DY, Prince DE. Congenital femoral deficiency reconstruction and lengthening surgery. Pediatric Lower Limb Deformities: Principles and Techniques of Management. 2016:361-425.

16. Park C, Merchant I. Complications of total hip replacement. InTotal Hip Replacement-An Overview 2018 Nov 5. IntechOpen.

17. Deshmukh S, Omar IM. Imaging of hip arthroplasties: normal findings and hardware complications. In Seminars in Musculoskeletal Radiology 2019 Apr (Vol. 23, No. 02, pp. 162-176). Thieme Medical Publishers.

18. Upadhyay A, York S, Macaulay W, McGrory B, Robbennolt J, Bal BS. Medical malpractice in hip and knee arthroplasty. The Journal of arthroplasty. 2007 Sep 1;22(6):2-7.

19. Azar FM, Canale ST, Beaty JH. Campbell's Operative Orthopaedics, E-Book. Elsevier Health Sciences; 2020 Dec 23.

20. Tagomori H, Kaku N, Tabata T, Tsumura H. A new and simple intraoperative method for correction of leg-length discrepancy in total hip arthroplasty. Journal of orthopaedics. 2019 Sep 1;16(5):405-8.

21. Chen X, Xiong J, Wang P, Zhu S, Qi W, Peng H, Yu L, Qian W. Robotic-assisted compared with conventional total hip arthroplasty: systematic review and meta-analysis. Postgraduate Medical Journal. 2018 Jun;94(1112):335-41.

22. Hosoyama T, Kaku N, Tagomori H, Shibuta Y, Tsumura H. Relationship between perceived and structural leg length discrepancies of patients with hip osteoarthritis dysplasia. Orthopaedics & Traumatology: Surgery & Research. 2023 Jun 1;109(4):103570.

23. Aubert T, Rigoulot G, Gerard P, Auberger G, Leclerc P. Restoration of hip anatomy using computer modelling prior to total hip arthroplasty and its potential consequences in terms of lower limb-length difference. HIP International. 2023 Dec 14:11207000231216937.

24. Knutson GA. Anatomic and functional leg-length inequality: A review and recommendation for clinical decision-making. Part II, the functional or unloaded leg-length asymmetry. Chiropractic & Osteopathy. 2005 Dec;13(1):1-6.

25. Knutson GA. Anatomic and functional leg-length inequality: a review and recommendation for clinical decision-making. Part I, anatomic leg-length inequality: prevalence, magnitude, effects and clinical significance. Chiropractic & osteopathy. 2005 Dec;13(1):1-0.

26. Ng VY, Kean JR, Glassman AH. Limb-length discrepancy after hip arthroplasty. JBJS. 2013 Aug 7;95(15):1426-36.

27. Dong N, Yang C, Li SQ, Gao YH, Liu JG, Qi X. Effect of preoperative leg length discrepancy on functional outcome and patient satisfaction after total hip arthroplasty in cases of osteonecrosis of the femoral head. The Journal of arthroplasty. 2016 Dec 1;31(12):2789-94.

28. Papadopoulos DV, Koulouvaris P, Aggelidakis GC, Tsantes AG, Lykissas MG, Mavrodontidis A. Intraoperative measurement of limb lengthening during total hip arthroplasty. Indian journal of orthopaedics. 2017Apr;51:162-7.

29. Gurney B, Mermier C, Robergs R, Gibson A, Rivero D. Effects of limb-length discrepancy on gait economy and lower-extremity muscle activity in older adults. JBJS. 2001 Jun 1;83(6):907-15.

30. Murray KJ, Azari MF. Leg length discrepancy and osteoarthritis in the knee, hip and lumbar spine. The Journal of the Canadian Chiropractic Association. 2015 Sep;59(3):226.

31. Pai S. Medico-legal issues related to hip and knee arthroplasty: a literature review including the Indian scenario. Indian Journal of Orthopaedics. 2021 Oct;55(5):1286-94.

32. Patterson DC, Grelsamer RP, Bronson MJ, Moucha CS. Lawsuits after primary and revision total hip arthroplasties: a malpractice claims analysis. The Journal of arthroplasty. 2017 Oct 1;32(10):2958-62.

33. Patterson DC, Grelsamer R, Bronson MJ, Moucha CS. Lawsuits after primary and revision total knee arthroplasty: a malpractice claims analysis. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2017 Oct 1;25(10):e235-42

34. Evans JT, Blom AW, Timperley AJ, Dieppe P, Wilson MJ, Sayers A, Whitehouse MR. Factors associated with implant survival following total hip replacement surgery: A registry study of data from the National Joint Registry of England, Wales, Northern Ireland and the Isle of Man. PLoS Medicine. 2020 Aug 31;17(8):e1003291.

35. Deere KC, Whitehouse MR, Porter M, Blom AW, Sayers A. Assessing the non-inferiority of prosthesis constructs used in hip replacement using data from the National Joint Registry of England, Wales, Northern Ireland and the Isle of Man: a benchmarking study. BMJ open. 2019 Apr 1;9(4):e026685.

36. Ortho Bullets. THA Leg Length Discrepancy. Available at: http://www.orthobullets.com/recon/12115/tha-leglengthdiscrepancy? ExpandeftMenu=true.

37. McWilliams AB, Lampropoulos A, Stone MH. Revision surgery for leg length inequality after primary hip replacement. Hip International. 2018 Sep;28(5):554-8.

38. Edeen J, Sharkey PF, Alexander AH. Clinical significance of leg-length inequality after total hip arthroplasty. American journal of orthopedics (Belle Mead, NJ). 1995 Apr 1;24(4):347-51.

39. McCaw ST, Bates BT. Biomechanical implications of mild leg length inequality. British journal of sports medicine. 1991 Mar;25(1):10.

40. White TO, Dougall TW. Arthroplasty of the hip: leg length is not important. The Journal of Bone & Joint Surgery British Volume. 2002 Apr 1;84(3):335-8.

41. Gurney B, Mermier C, Robergs R, Gibson A, Rivero D. Effects of limb-length discrepancy on gait economy and lower-extremity muscle activity in older adults. JBJS. 2001 Jun 1;83(6):907-15.

42. Flecher X, Ollivier M, Argenson JN. Lower limb length and offset in total hip arthroplasty. Orthopaedics & Traumatology: Surgery & Research. 2016 Feb 1;102(1):S9-20.

43. Konyves A, Bannister GC. The importance of leg length discrepancy after total hip arthroplasty. The Journal of Bone & Joint Surgery British Volume. 2005 Feb 1;87(2):155-7.

44. Montalti M, Castagnini F, Giardina F, Tassinari E, Biondi F, Toni A. Cementless total hip arthroplasty in Crowe III and IV dysplasia: high hip center and modular necks. The Journal of Arthroplasty. 2018 Jun 1;33(6):1813-9.

45. Gupta R, Pathak P, Singh R, Majumdar KP. Double-stitch technique: a simple and effective method to minimize limb length discrepancy after total hip arthroplasty. Indian Journal of Orthopaedics. 2019 Feb;53:169-73.

46. Jasty M, Webster W, Harris W. Management of limb length inequality during total hip replacement. Clinical Orthopaedics and Related Research®. 1996 Dec 1;333:165-71.

47. Dilogo IH, Fahrudhin MT, Canintika AF. How is the outcome of primary difficult total hip arthroplasty? A cross-sectional study. International Journal of Surgery Open. 2019 Jan 1;21:68-72.

48. Tagomori H, Kaku N, Tabata T, Tsumura H. A new and simple intraoperative method for correction of leg-length discrepancy in total hip arthroplasty. Journal of orthopaedics. 2019 Sep 1;16(5):405-8.

49. What is limb length discrepancy. (cited jan 2023); Available from: URL:https://www.limblength.org/conditions/limb-length-discrepancy-lld/

50. Papadopoulos DV, Koulouvaris P, Aggelidakis GC, Tsantes AG, Lykissas MG, Mavrodontidis A. Intraoperative measurement of limb lengthening during total hip arthroplasty. Indian journal of orthopaedics. 2017 Apr;51:162-7.

51. Du YQ, Sun JY, Ma HY, Wang S, Ni M, Zhou YG. Leg length balance in total hip arthroplasty for patients with unilateral Crowe type IV developmental dysplasia of the hip. Orthopaedic surgery. 2020 Jun;12(3):749-55.

52. Moslemi A, Kierszbaum E, Descamps J, Sigonney F, Biau D, Anract P, Hardy A. Does using the direct anterior approach with a standard table for total hip arthroplasty reduce leg length discrepancies? Comparative study of traction table versus standard table. Orthopaedics & Traumatology: Surgery & Research. 2021 Feb 1;107(1):102752.

53. Mo TT, Zhu YS, Zhang JN, Zhang WK, Jiang C. The clinical effect of trochanteric slide osteotomy combined with a cementless femoral conical stem in total hip replacement for the treatment of Crowe type IV developmental dysplasia of the hip. Technology and Health Care. 2023 Jan 1(Preprint):1-1.

54. Ma JM, Lu HL, Chen XX, Yang X, Wang Q. Impact of proximal femoral shape on leg length discrepancy after total hip arthroplasty. Zhongguo gu Shang= China Journal of Orthopaedics and Traumatology. 2021 Jul 1;34(7):641-5.

55. López RE, de Tomás JP, Varela MM, Pérez JR. Comparison of leg length discrepancy correction after the use of a modular neck stem and its monoblock homologue in total primary hip arthroplasty. Revista espanola de cirugia ortopedica y traumatologia. 2022;66(6):445-53.

56. Hardwick-Morris M, Wigmore E, Twiggs J, Miles B, Jones CW, Yates PJ. Leg length discrepancy assessment in total hip arthroplasty: is a pelvic radiograph sufficient. Bone & Joint Open. 2022 Dec 23;3(12):960-8.

57. Hirano Y, Imai N, Nozaki A, Horigome Y, Suzuki H, Kawashima H. The association of postoperative global femoral offset with total hip arthroplasty outcomes. Scientific Reports. 2023 Jan 28;13(1):1621.

58. Doehrmann R, Comer BJ, Chatterji R, Diedring B, Knapp P, Afsari A. Accuracy of Leg Length and Hip Offset Measurements Using a Fluoroscopic Grid During Anterior Approach Total Hip Arthroplasty. Arthroplasty Today. 2023 Aug 1;22:101154.

59. Gheewala RA, Young JR, Villacres Mori B, Lakra A, DiCaprio MR. Perioperative management of leg-length discrepancy in total hip arthroplasty: a review. Archives of Orthopaedic and Trauma Surgery. 2023 Jan 11:1-7.

60. Shete S, Patil K, Saidapur SK, Chauhan S. A prospective clinical study of Limb Length Discrepancy in THR using lateral surgical approach. European Journal of Molecular & Clinical Medicine. 2023;10(1):4577-85.

61. Harris.W.H,Harris-Hip-score.(cited-June-2007) Available from URL :http://orthopaedicscores.com/scorepages/harris_hip_score.html

62. Gallo MC, Chung BC, Tucker DW, Piple AS, Christ AB, Lieberman JR, Heckmann ND. Limb length discrepancy in total hip arthroplasty: is the lesser trochanter a reliable measure of leg length?. The Journal of Arthroplasty. 2021 Oct 1;36(10):3593-600.

63. Dunn H, Rohlfing G, Kollmorgen R. A comparison of leg length discrepancy between direct anterior and anterolateral approaches in total hip arthroplasty. Arthroplasty. 2020 Dec;2(1):1-6.

64. Wroblewski B.M., Paul D. Siney, Patricia A. Fleming. Charnley Low-Frictional Torque Arthroplasty of the Hip. Ed1. Switzerland, Springer International 2016

65. Smolle MA, Fischerauer SF, Maier M, Reinbacher P, Friesenbichler J, Ruckenstuhl P, Grandesso M, Leithner A, Maurer-Ertl W. Leg length measures appear inaccurate in the early phase following total hip arthroplasty. Scientific Reports. 2021 Dec 1;11(1):23262.

66. Patel I, Nham F, Zalikha AK, El-Othmani MM. Epidemiology of total hip arthroplasty: demographics, comorbidities and outcomes. Arthroplasty. 2023 Dec;5(1):1-9.

67. Kumar P, Sen RK, Aggarwal S, Jindal K. Common hip conditions requiring primary total hip arthroplasty and comparison of their post-operative functional outcomes. Journal of Clinical Orthopaedics and Trauma. 2020 Mar 1;11:S192-5.

68. Brown TD, Johnston RC, Saltzman CL, Marsh JL, Buckwalter JA. Posttraumatic osteoarthritis: a first estimate of incidence, prevalence, and burden of disease. Journal of orthopaedic trauma. 2006 Nov 1;20(10):739-44.

69. Rasheed A, Shaukat MK, Alam F. Mean limb length discrepancy after total hip arthroplasty. Journal of Ayub Medical College Abbottabad-Pakistan. 2020 Aug 2;32.

70. Barber TC, Roger DB, Goodman SB, Schurman DJ. Early outcome of total hip arthroplasty using the direct lateral vs the posterior surgical approach. Orthopedics. 1996 Oct 1;19(10):873-5.

71. Desai AS, Dramis A, Board TN. Leg length discrepancy after total hip arthroplasty: a review of literature. Current reviews in musculoskeletal medicine. 2013 Dec;6:336-41.

72. Ranawat CS, Rodriguez J. Functional leg-length inequality following total hip arthroplasty. The Journal of arthroplasty. 1997 Jun 1;12(4):359-64.

73. Van de Velde S, Fillman R, Yandow S. The aetiology of protrusio acetabuli. Literature review from 1824 to 2006. Acta orthopaedica belgica. 2006 Oct 1;72(5):524-9.

74. Shih CH, Du YK, Lin YH, Wu CC. Muscular recovery around the hip joint after total hip arthroplasty. Clinical Orthopaedics and Related Research®. 1994 May 1;302:115-20.

75. Chou SW, Ueng SW, Lee MS. Muscular recovery of hip flexors and extensors after two-incision total hip arthroplasty. Chang Gung Med J. 2008 Nov 1;31(6):576-82.

76. Reardon K, Galea M, Dennett X, Choong P, Byrne E. Quadriceps muscle wasting persists 5 months after total hip arthroplasty for osteoarthritis of the hip: a pilot study. Internal medicine journal. 2001 Feb 15;31(1):7-14.

77. Tsikandylakis G, Mohaddes M, Cnudde P, Eskelinen A, Kärrholm J, Rolfson O. Head size in primary total hip arthroplasty. EFORT Open Reviews. 2018 May 21;3(5):225-31.

78. Burroughs BR, Hallstrom B, Golladay GJ, Hoeffel D, Harris WH. Range of motion and stability in total hip arthroplasty with 28-, 32-, 38-, and 44-mm femoral head sizes: an in vitro study. The Journal of arthroplasty. 2005 Jan 1;20(1):11-9.

79. Faldini C. Leg length discrepancy after primary total hip replacement. Musculoskeletal surgery. 2023 Mar;107(1):1-5.

80. Berger RA, Jacobs JJ, Meneghini RM, Della Valle C, Paprosky W, Rosenberg AG. Rapid rehabilitation and recovery with minimally invasive total hip arthroplasty. Clinical Orthopaedics and Related Research®. 2004 Dec 1;429:239-47.

81. Loder RT, Skopelja EN. The epidemiology and demographics of hip dysplasia. International Scholarly Research Notices. 2011;2011.

82. Turula KB, Friberg O, Lindholm TS, Tallroth K, Vanka E. Leg length inequality after total hip arthroplasty. Clinical Orthopaedics and Related Research (1976-2007). 1986 Jan 1;202:163-8.

83. Martin CT, Pugely AJ, Gao Y, Clark CR. A comparison of hospital length of stay and short-term morbidity between the anterior and the posterior approaches to total hip arthroplasty. The Journal of arthroplasty. 2013 May 1;28(5):849-54.

84. Fujita K, Kabata T, Kajino Y, Tsuchiya H. Optimizing leg length correction in total hip arthroplasty. International orthopaedics. 2020 Mar;44:437-43.

85. Konyves A, Bannister GC. The importance of leg length discrepancy after total hip arthroplasty. The Journal of Bone & Joint Surgery British Volume. 2005 Feb 1;87(2):155-7.

86. Innmann MM, Maier MW, Streit MR, Grammatopoulos G, Bruckner T, Gotterbarm T, Merle C. Additive influence of hip offset and leg length reconstruction on postoperative improvement in clinical outcome after total hip arthroplasty. The Journal of Arthroplasty. 2018 Jan 1;33(1):156-61.

87. Domb BG, Redmond JM, Louis SS, Alden KJ, Daley RJ, LaReau JM, Petrakos AE, Gui C, Suarez-Ahedo C. Accuracy of component positioning in 1980 total hip arthroplasties: a comparative analysis by surgical technique and mode of guidance. The Journal of Arthroplasty. 2015 Dec 1;30(12):2208-18.

88. Azizan NA, Basaruddin KS, Salleh AF. The effects of leg length discrepancy on stability and kinematics-kinetics deviations: A systematic review. Applied bionics and biomechanics. 2018 Jul 11;2018.

89. Yuan B, Taunton MJ, Trousdale RT. Total hip arthroplasty for alcoholic osteonecrosis of the femoral head. Orthopedics. 2009 Jun 1;32(6):400.

90. Stibolt Jr RD, Patel HA, Huntley SR, Lehtonen EJ, Shah AB, Naranje SM. Total hip arthroplasty for posttraumatic osteoarthritis following acetabular fracture: A systematic review of characteristics, outcomes, and complications. Chinese Journal of Traumatology. 2018 Jun 1;21(03):176-81.

91. Whitehouse MR, Stefanovich-Lawbuary NS, Brunton LR, Blom AW. The impact of leg length discrepancy on patient satisfaction and functional outcome following total hip arthroplasty. The Journal of arthroplasty. 2013 Sep 1;28(8):1408-14.

9. ANNEXURE - A – ETHICAL APPROVAL CERTIFICATE

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH
EMPOWERING PROFESSIONALS
Deemed-to-be-University u/s 3 of the UGC Act, 1956

KLE ACADEMY OF HIGHER EDUCATION AND

(Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)
JNMC Campus, Nehru Nagar, Belagavi-590 010, Karnataka State, India
☎: 0831-2444444 **FAX:** 0831-2493777 **Web:** http://www.kledeemeduniversity.edu.in
E-mail: info@kledeemeduniversity.edu.in

Ref.No.KAHER/Ethic/2018-19/D- 120 29th May 2018

To,
Dr. Sarang Shete
Ph.D. Part-Time Research Scholar,
Faculty of Medicine, 2017-18 Batch,
KAHER, **Belagavi**

Dear Research Scholar,

Sub:- Regarding Ethical Clearance.

The KLE University **Ethics Committee on Human Subjects** for Ph. D Research Project met on **Thursday, 19th April 2018** to consider your application for approval of the research project **"Determinants of Limb Length discrepancy in total HIP Arthroplasty: A cohort study in tertiary care hospital."**

As there are no ethical issues involved in your proposed research project, the Committee has provided approval for this research project.

You are requested to report to Ethical Committee in case of the following:

1. Any deviation from or change of the protocol.
2. All serious adverse events.
3. Any changes in study documents.

(Dr. Anita Dalal)
Member Secretary,
Ph.D. Ethical Committee (Human),
KAHER, Belagavi

(Dr. Anil Hogade)
Chairman
Ph.D. Ethical Committee (Human),
KAHER, Belagavi.

CC to: - The Director Academic Affairs, KAHER, Belagavi.
- The Director Research Foundation, KAHER, Belagavi.
- The Registrar, KAHER, Belagavi

ANNEXURE - B – PIS + CONSENT

PATIENT INFORMATION SHEET

Total Hip Arthroplasty

Introduction:

Total hip arthroplasty is a surgical procedure which involves replacing damage arthritic hip with artificial components. The damaged surfaces in this surgery are acetabular cup and femoral head. The artificial components implanted are termed as prosthesis. The concept is to reconstruct the joint for restoration of its function. It follows modern surgical and biomechanical principles to give painless stable yet movable hip joint.

Importance of procedure

Normal hip joint consists of a round head (ball) of thigh bone(socket/cup) at the pelvis in a ball and socket arrangement. A healthy joint has a remarkable mechanism due to perfect matching of the ball with the socket. A smooth and strong layer of articular cartilage (like velvet) aids it. This lining acts as a padding to absorb stresses and ensures almost frictionless movement of your hip joint. Your hip joint is designed to withstand a lifetime of strenuous activity. However owing to various diseases arthritis of hip joint causes erosion of this velvet layer (cartilage layer), leading to pain, stiffness and difficulty in walking. Hip joint is one of the largest weight bearing joint in the body and activities like walking, jumping, sitting, dancing, swimming , climbing, etc depends on ones hip. However once the hip is damaged the hip becomes stiff and painful. These activities of daily living needs considerable efforts or are restricted in an diseased or arthritic hip.. The importance of the procedure lies in restoring the diseased hip joint with a well established and successful surgical procedure which has evolved in the form of total hip arthroplasty, as it provides freedom from pain and stiffness but also improves quality of life. This specialized operation is now very successful and has been accepted very well by both the medical fraternity and society.

Pre-procedure preparation:

Standard pre-operative fitness for surgery involves numerous investigations and blood checkup: hemogram with esr, hscrp,thyroid function test, liver function test , kidney function test, lipid panel, viral markers like HbSAg, HIV, HCV. Urine routine microscopy, diabetic tests, cardiac evaluations and routine x-rays: x-ray for both hips and chest x-ray. Physicians and anesthetic evaluation by general physician and anesthetist done. Clinical assessment for

hip movements and limb length measurements taken. Fasting for 8 hours is required prior to the procedure.

The procedure:

Under combined spinal epidural / general anesthesia patient's affected hip will be opened surgically .for removal of damaged ball (femoral head), femoral neck cut will be executed and preparation of femoral canal for artificial femoral implant prosthesis/stem will be done. Similarly , on diseased acetabular side (cup side) will be prepared using standard reamers and artificial cup, either cemented or uncemented will be fixed. The stem will be implanted with metallic or ceramic ball and the hip joint will be reduced thus completing an artificial bearing of ball and socket joint. The hip will be closed in layers using a temporary removable drain where ever appropriate. Wound will be sutured and dressing will be applied.

Post-procedure care:

As after the completion of the procedure, patient will be monitored in post operative recovery and then shifted to the wards. Appropriate analgesia provided and periodic hemodynamic assessment will be done. Removal of drain tubes will be done on any of the first 3 post-operative days depending on the quantity of drain. Patients will be encouraged and will be ambulated with walker in first 3 post-operative days depending on the nature of surgery and patients post surgical status.

Risk and complication:

A. Anesthesia related complications, they are same as in any other mar surgery.
B. Any major surgery related complications, they are blood clots in leg(deep vein thrombosis), or in lung(pulmonary embolism)etc.
C. Total hip surgery related complications, they are less common. Some of these cases may even require a revision surgery. Some of these complications are:
    - Dislocation of the artificaila hip joint: incidence of this complication is low and most of them normally require closed reduction and splinting. But if the artificial joint dislocated repeadly then a revision surgery may be required.
    - Infection: it is the significant complication in the artificial hip joint. Hpwever , the incidence of serious hip joint infections (superficial or deep) respond

favorably to antibiotics, but if the discharge continues, then one may require removal of artificial hip joint for the control of infection.

- Minor leg length difference.

D. The major long term problem is loosening of hip joint prosthesis. The other long term complication is wearing of the plastic cup.

Remarks :

The list of complications is not exhaustive and other unforeseen complications may occasionally occur. The risk quoted is for general reference only. If a complication developed, another surgical procedure or treatment may be required immediately as in any major surgical operations. These additional costs or whatsoever cost will not be bore by the institution, hospital or the surgeon.Thus,if subsequent surgeries if needed had to be paid by the patient.

Advantages:

1. Pain relief from old arthritic hip.
2. Freedom of movement at the joint.
3. Stable hip joint with Improvement in functional ability.

Disadvantage:

1. Artificial hip joint is a good hip joint but not a natural one.
2. To avoid accelerated wear and tear in the form of edge loading of the artificial bearing, one has to avoid cross leg sitting, squatting and activities which increase excessive joint reaction forces like jumping.

Financial Incentives:

You will not receive any financial support for participating in this study.

Authorization of Publication:

The result of the study will be used for publication. However the participant identity will be kept confidential.

Questions:

If you have any questions about the study, you should contact **Dr. SARANG SHETE**, Asst. Professor, Department of Orthopedics, JNMC, Nehru Nagar, Belagavi. Contact no: - 9015442838. You can also contact **DR. KIRAN PATIL,** MBBS, D.Ortho, MS(Ortho). Professor, Faculty of Orthopedics, JNMC, Nehru nagar, belagavi.

If you have any question about your right as a study participant, you may contact **Dr. A.P Hogade** MD, Chairperson, Institutional Ethical Committee, J. N. Medical College, KLE University, and Belagavi at phone line – (0831-2473777 Extension 4052).

Legal Rights:

By signing this consent form, we are not waving any of your legal rights.

INFORMED CONSENT STATEMENT:

I am making a voluntary decision to participate in the study " Determinants of limb length discrepancy in Total Hip Arthroplasty-A cohort study in tertiary care hospital."

I have been explained about the methodology of the study. As a part of it, I permit to perform the surgical procedure on me. I have been explained about the possible risks involved in study. I have been explained about the merits and demerits of the procedures involved in study and have been told about the possible risk involved in the study. I am giving consent for enrolling myself to the above mentioned study. I am giving my signature/left thumb impression on this consent form for the same.

Name of the Participant:

Signature / left thumb impression of the Participant

Name of the Witness:

Signature of the Witness

Name of the Researcher:

Signature of the Researcher

Date:

ANNEXURE - C – HARRIS HIP SCORE QUESTIONNAIRE

www.orthopaedicscores.com

Date of completion
December 27, 2023

Harris Hip Score

(With the permission of the Journal of Bone & Joint Surgery)

Clinician's name (or ref) _____ **Patient's name (or ref)** _____

Please answer the following questions.

Section 1

Pain	**Support**
◯ None, or ignores it	◯ None
◯ Slight, occasional, no compromise in activity	◯ Cane/Walking stick for long walks
◯ Mild pain, no effect on average activities, rarely moderate pain with unusual activity, may take aspirin	◯ Cane/Walking stick most of the time
◯ Moderate pain, tolerable but makes concessions to pain. Some limitations of ordinary activity or work. May require occasional pain medication stronger than aspirin	◯ One crutch
◯ Marked pain, serious limitation of activities	◯ Two Canes/Walking sticks
◯ Totally disabled, crippled, pain in bed, bedridden	◯ Two crutches or not able to walk

Distance walked	**Limp**
◯ Unlimited	◯ None
◯ Six blocks (30 minutes)	◯ Slight
◯ Two or three blocks (10 - 15 minutes)	◯ Moderate
◯ Indoors only	◯ Severe or unable to walk
◯ Bed and chair only	

Activities - shoes, socks	**Stairs**
◯ With ease	◯ Normally without using a railing
◯ With difficulty	◯ Normally using a railing
◯ Unable to fit or tie	◯ In any manner
	◯ Unable to do stairs

Public transportation	**Sitting**
◯ Able to use transportation (bus)	◯ Comfortably, ordinary chair for one hour
◯ Unable to use public transportation (bus)	◯ On a high chair for 30 minutes
	◯ Unable to sit comfortably on any chair

To score this section all four must be 'yes', then get 4 points. Nb. Not 1 point for each four or nothing.

Section 2

Does your patient have ALL of the following: -

◯ yes
◯ no

Less than 30degrees of fixed flexion
Less than 10 degrees of fixed int rotation in extension
Less than 10 degrees of fixed adduction
Limb length discrepancy less than 3.2 cm (1.5 inches)

Section 3 - Motion

Total degrees of Flexion	**Total degrees of Abduction**
◯ None	◯ None
◯ 0 >8	◯ 0 > 5
◯ 8 > 16	◯ 5 > 10
◯ 16 > 24	◯ 10 > 15
◯ 24 > 32	◯ 15 > 20
◯ 32 > 40	**Total degrees of Ext Rotation**
◯ 40 > 45	◯ None

○ 45 > 55	○ 0 > 5
○ 55 > 65	○ 5 > 10
○ 65 > 70	○ 10 > 15
○ 70 > 75	**Total degrees of Adduction**
○ 75 > 80	○ None
○ 80 > 90	○ 0 > 5
○ 90 > 100	○ 5 > 10
○ 100 > 110	○ 10 > 15

Print page | Close Window | Reset

To save this data please print or Save As CSV

The Harris Hip Score is: 0

Nb: This page cannot be saved due to patient data protection so please print the filled in form before closing the window.

Grading for the Harris Hip Score

Successful result

=post operative increase in Harris Hip Score of > 20 points + radiographically stable implant + no additional femoral reconstruction

Or

<70 Poor | 70 - 79 Fair | 80-89 Good | 90 -100 Excellent

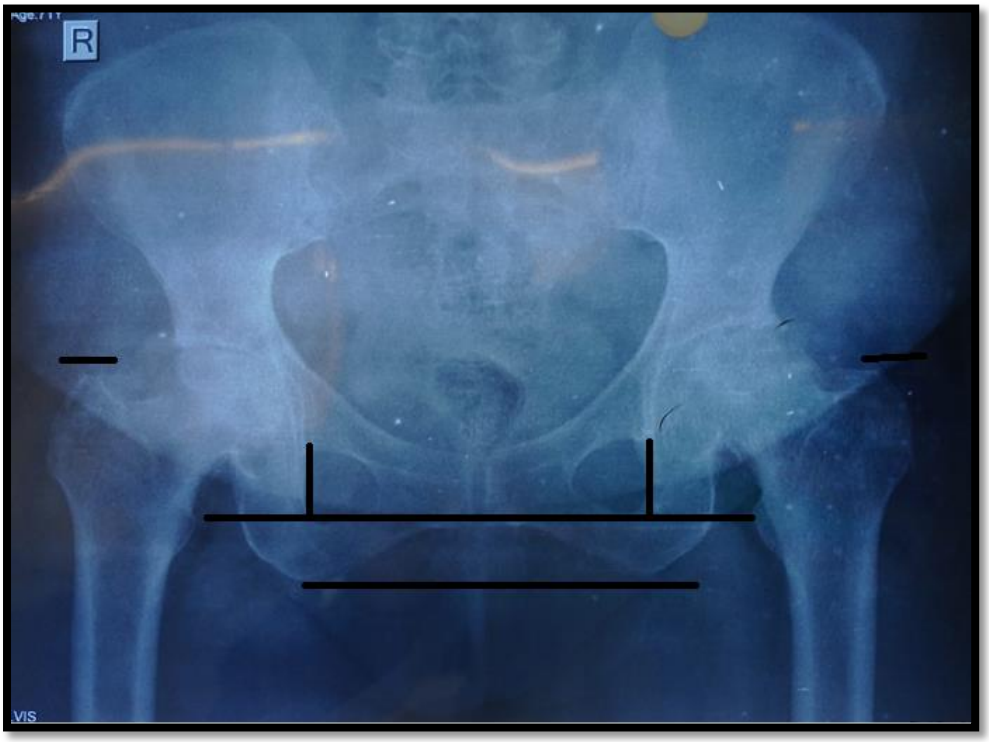
Reference for Score: Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am. 1969 Jun;51(4):737-55. **Link**

Reference for grading: Marchetti P, Binazzi R, Vaccari V, Girolami M, Morici F, Impallomeni C, Commessatti M, Silvello L. Long-term results with cementless Fitek (or Fitmore) cups. J Arthroplasty. 2005 Sep;20(6):730-7.

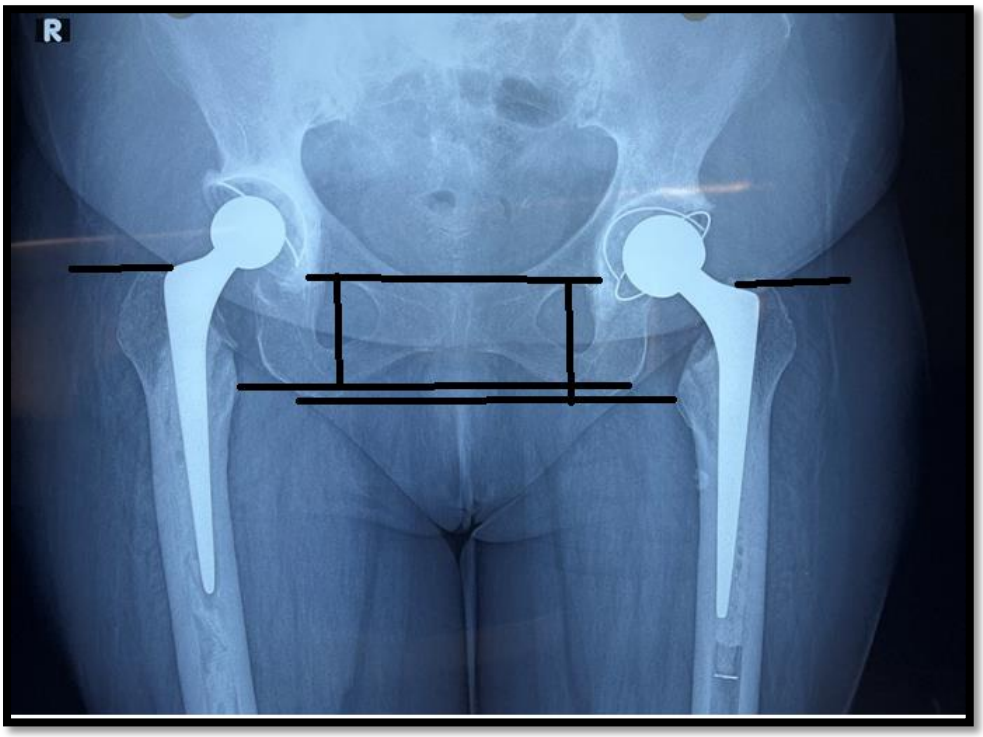
Web Design London - James Blake Internet

ANNEXURE - D – CASE EXAMPLES

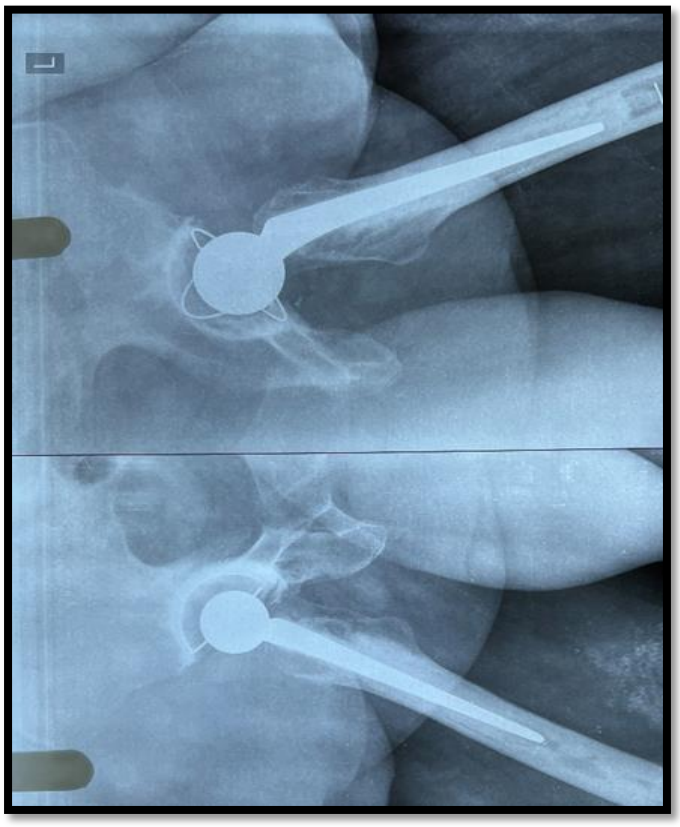
CASE 1



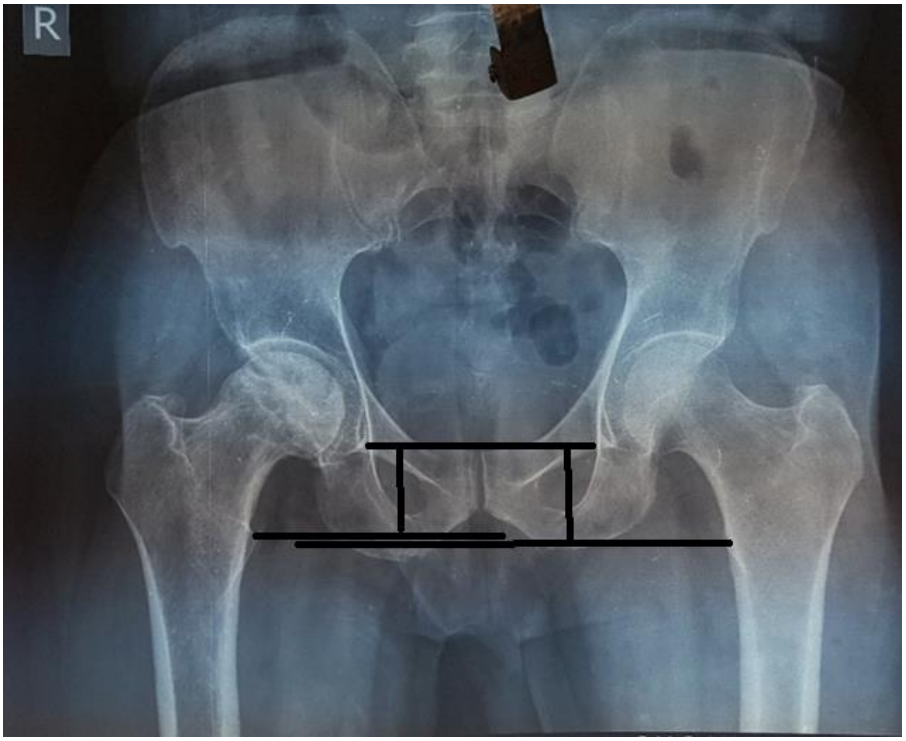
CASE 1



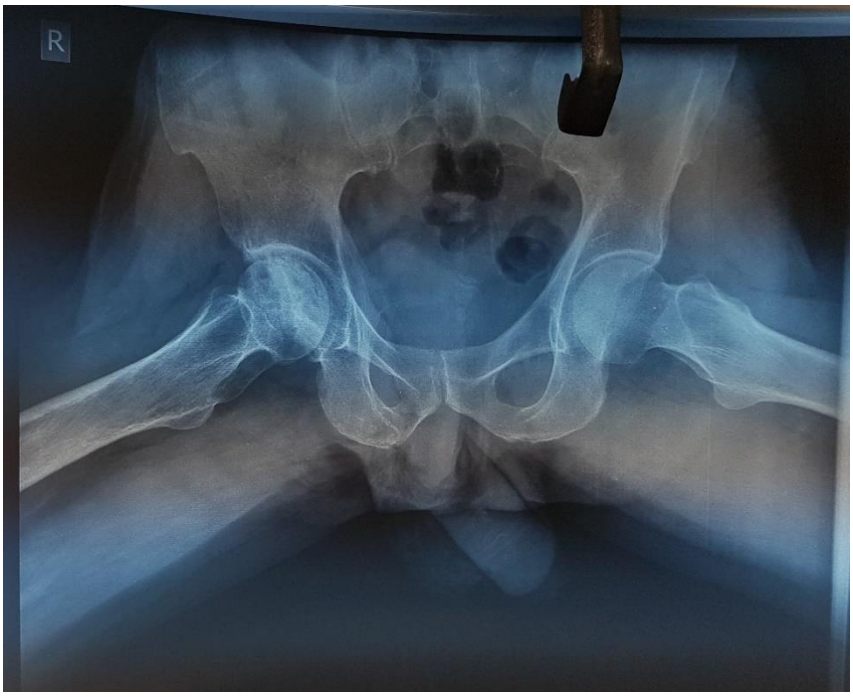
CASE 1



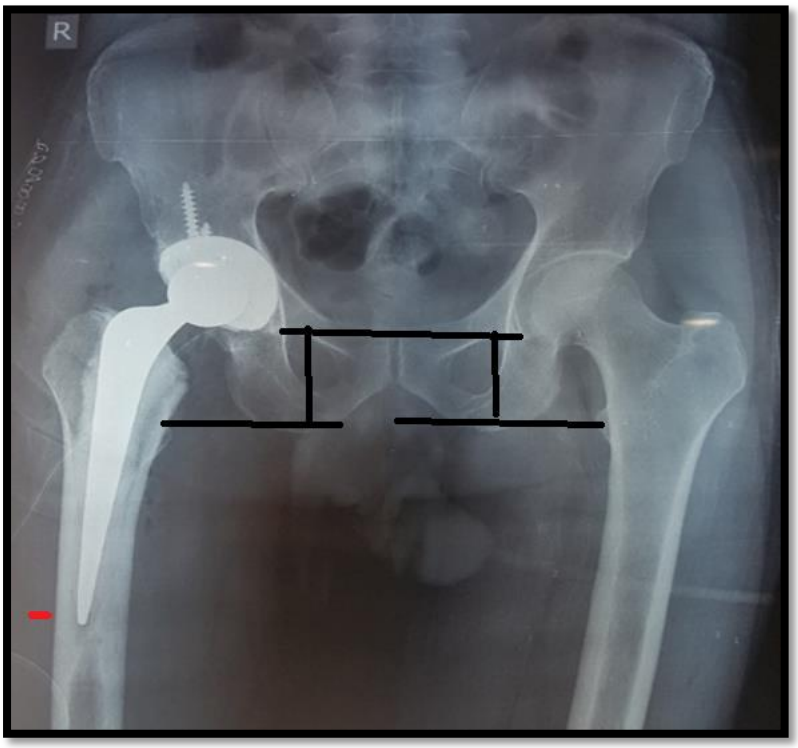
CASE 2 PRE OP



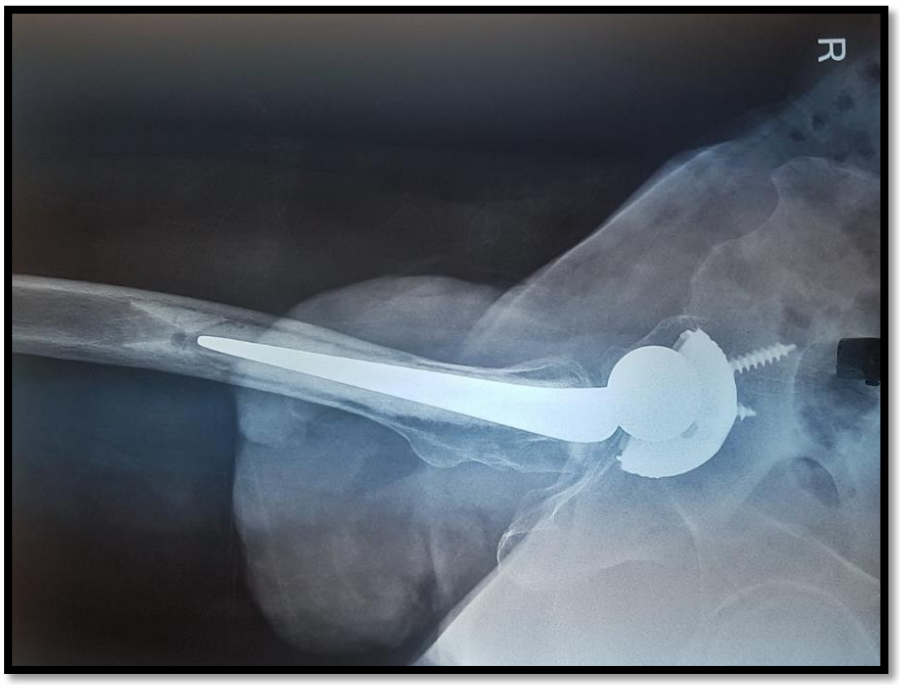
CASE 2 PRE OP



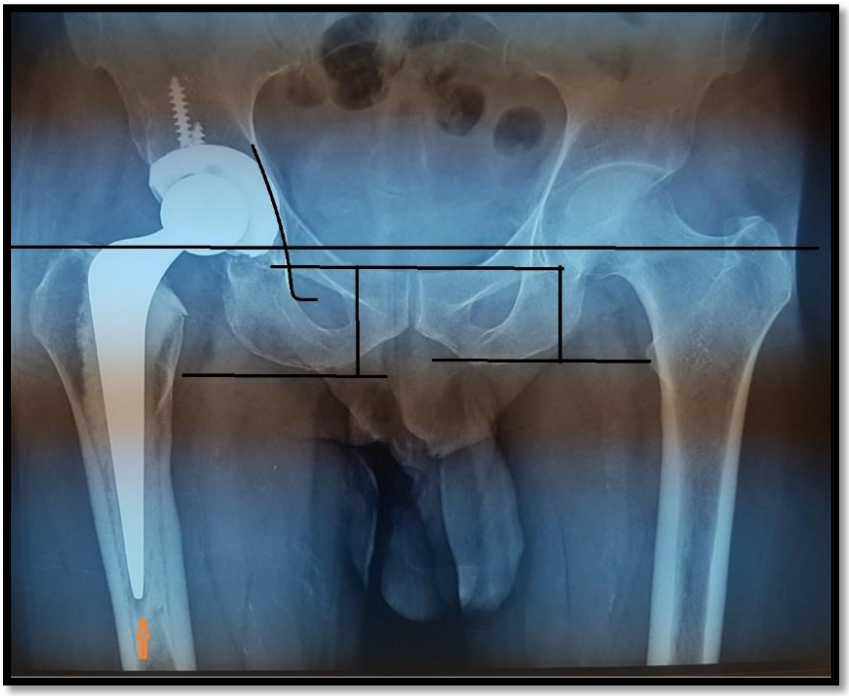
CASE 2 POST OP



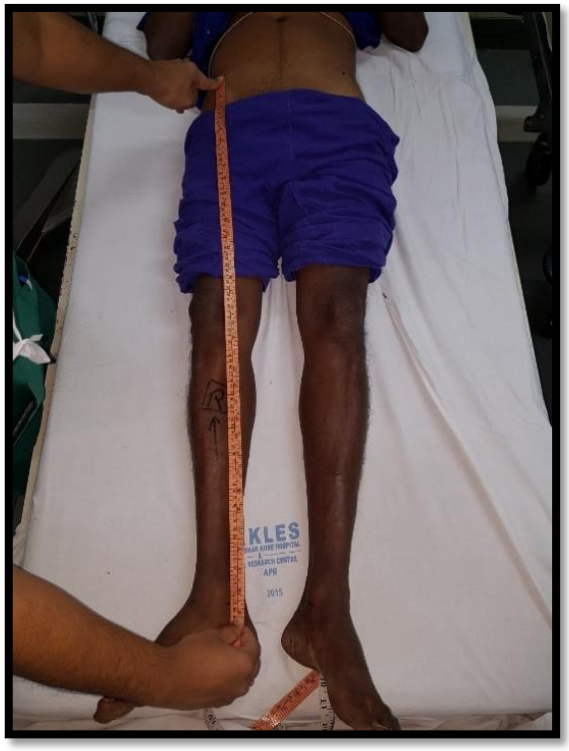
CASE 2 POST OP

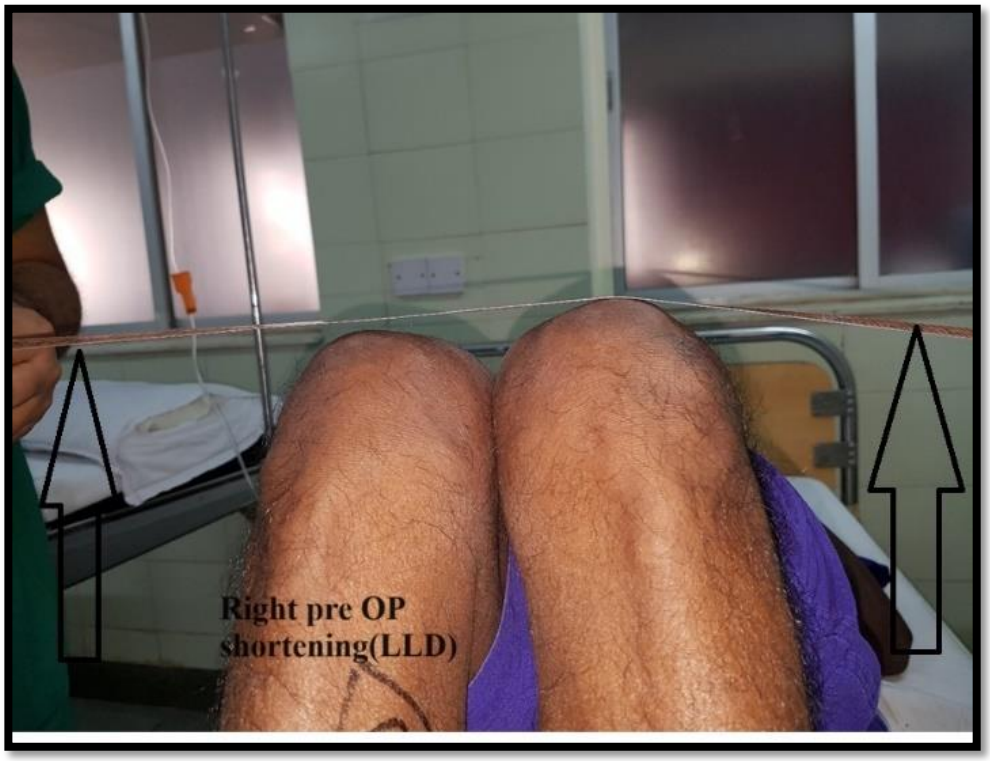


CASE 2 POST OP WITH LLD & VARUS STEM TIP

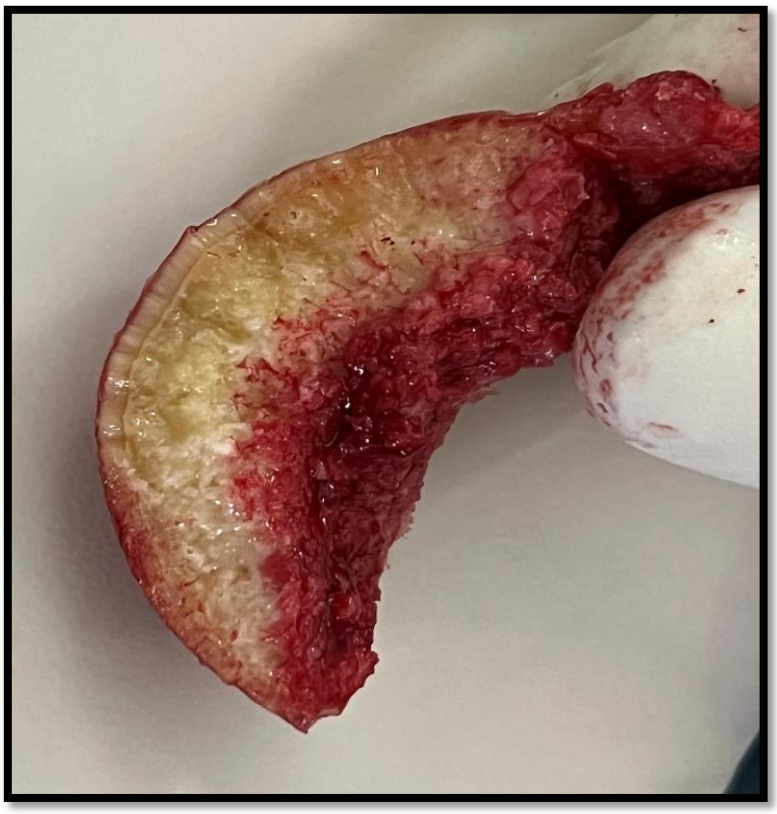


CASE 2 CLINICAL MESUREMENT PRE OP

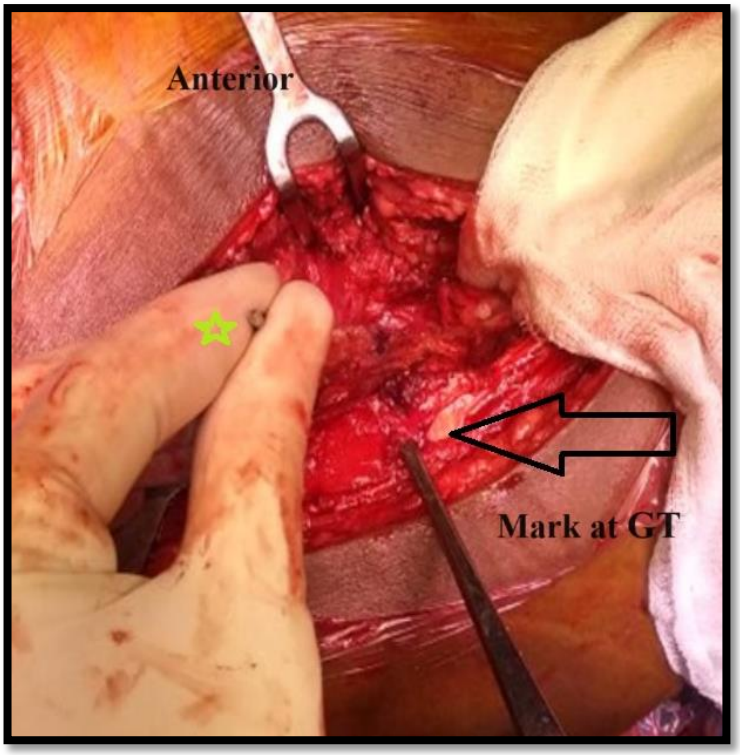




CASE 2 SECTION OF AVN-OSTEONECROSIS OF FEMORAL HEAD

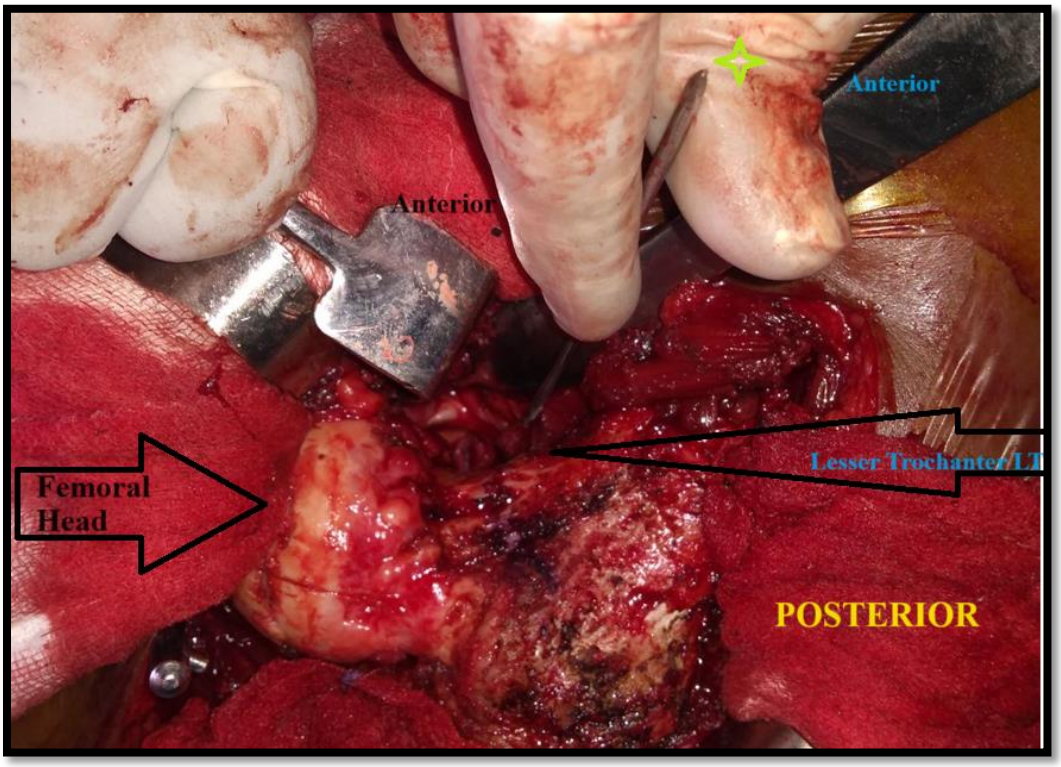


CASE 2 Intra OP Pre Neck cut LLD
★(Steinmin Pin)



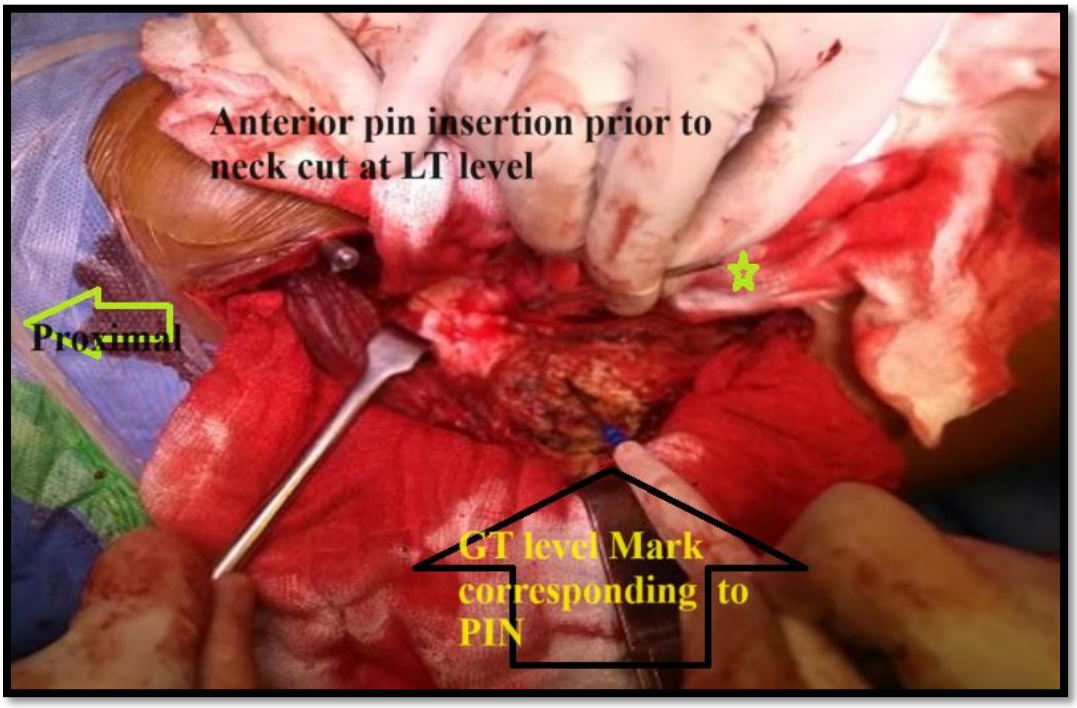
CASE 2 Intra OP Pre Neck cut LLD Zoom view

★(Steinmin Pin)

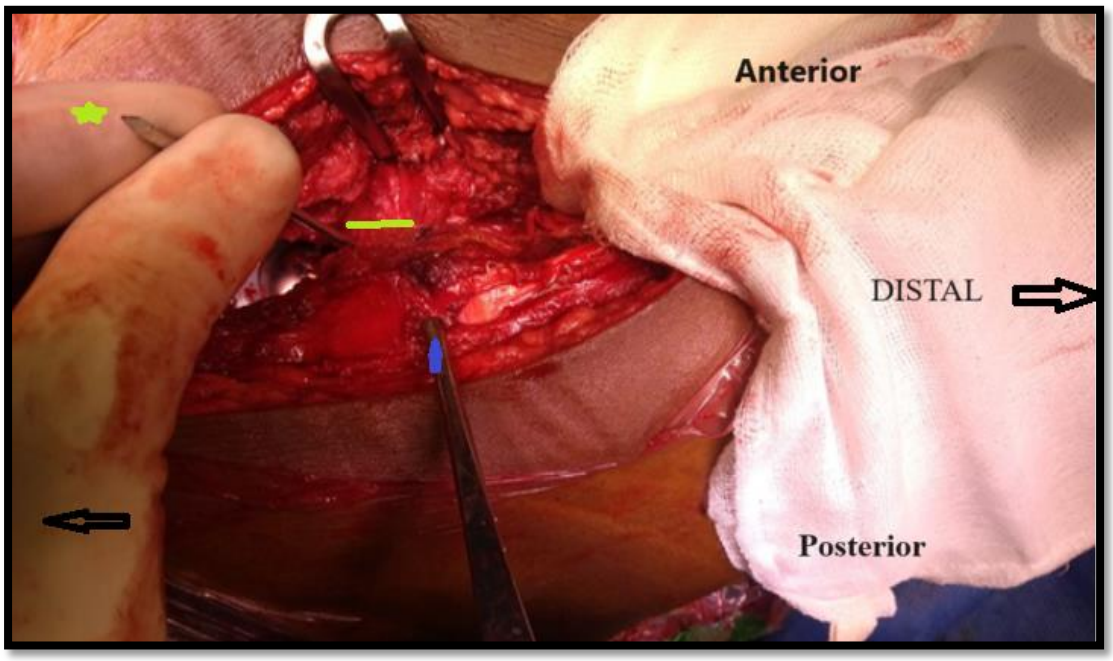


CASE 2 Intra OP Post Reduction LLD

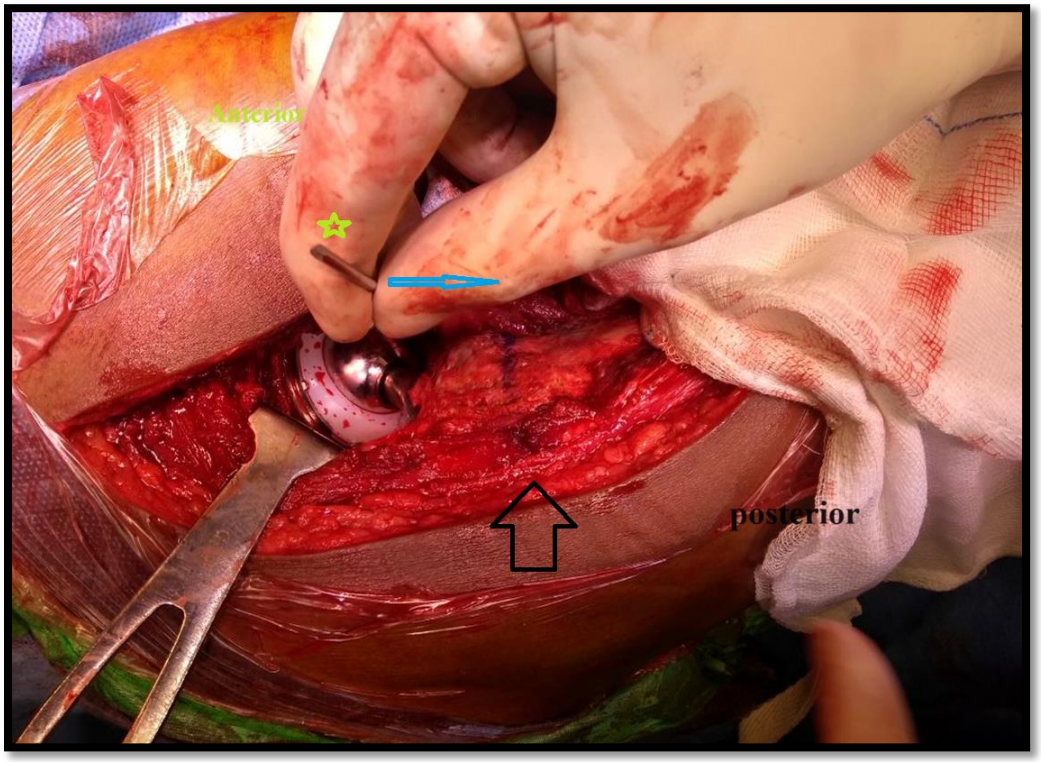
★(Steinmin Pin)



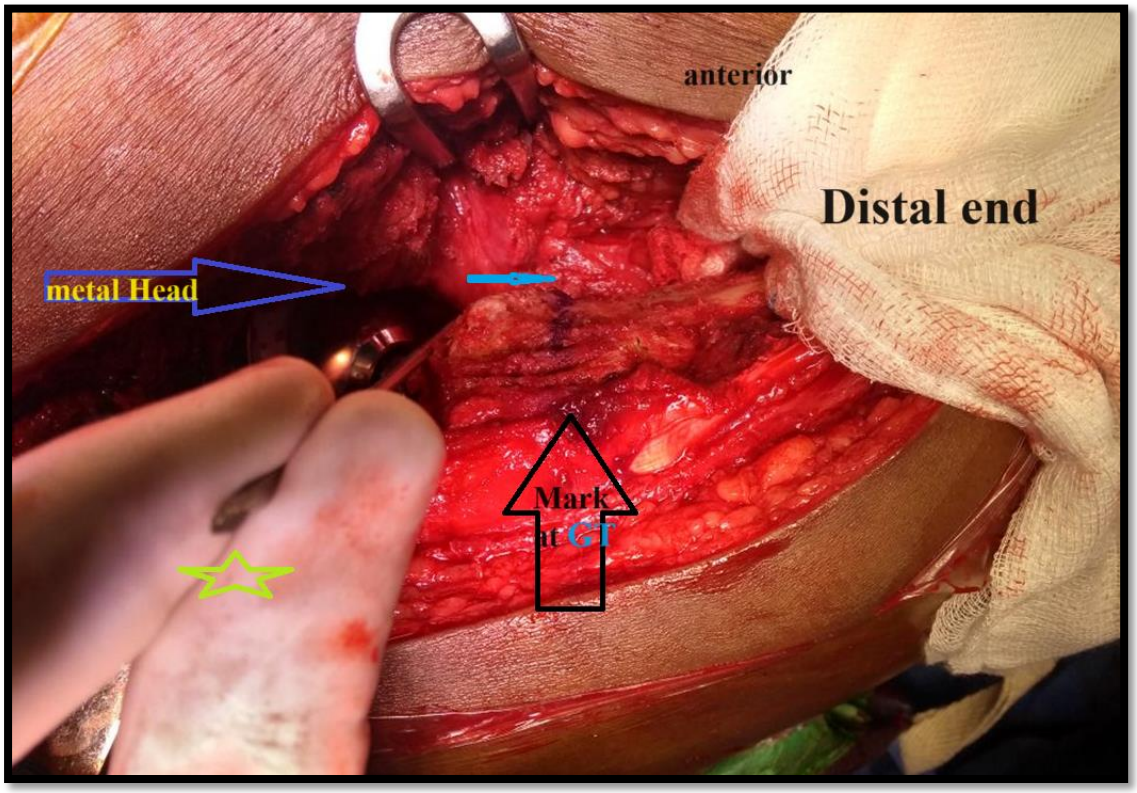
CASE 2 Intra OP Post Reduction LLD (Zoom View)
★ (Steinmin Pin)



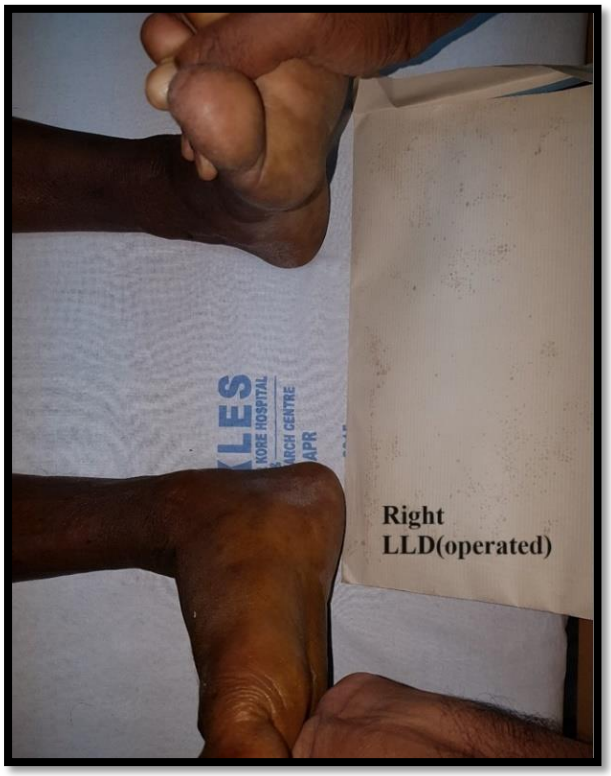
CASE 2 Intra OP Post Reduction LLD (Zoom View)
★ (Steinmin Pin)



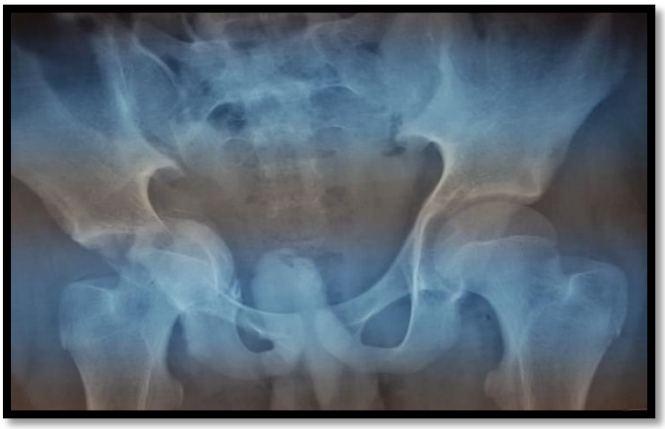
CASE 2 Intra OP Post Reduction LLD (Zoom View)
★(Steinmin Pin)



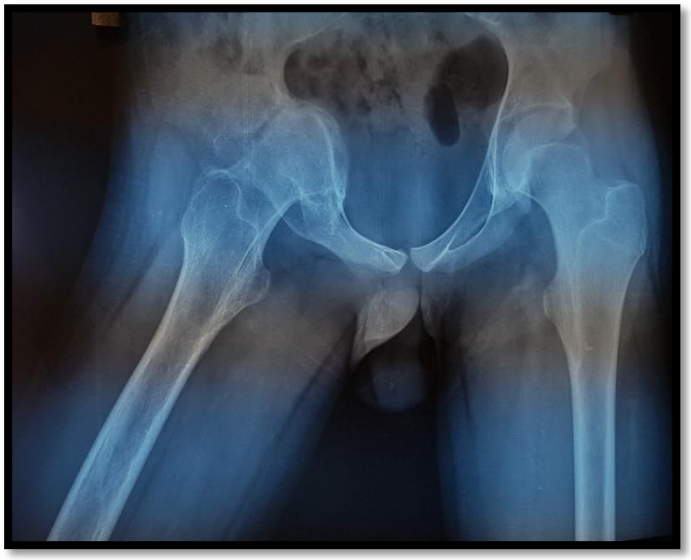
CASE 2 Increased LLD Clinically

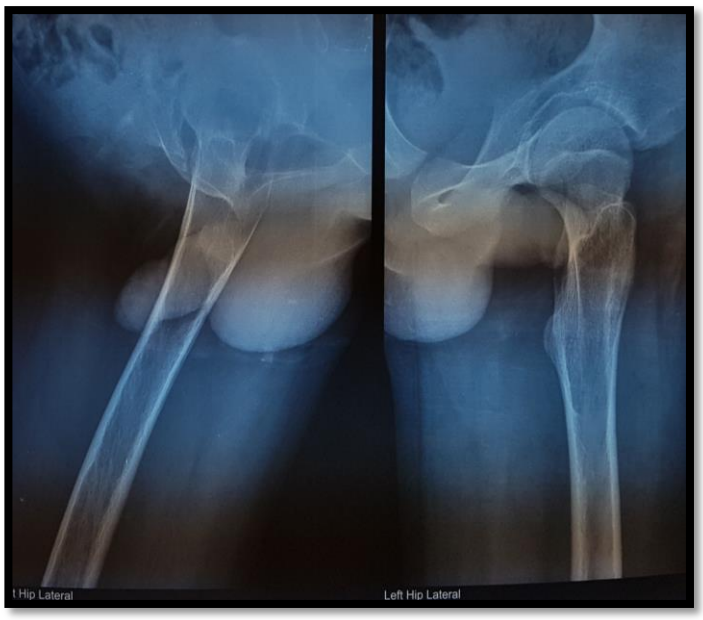


CASE 3 Neglected FRACTURE dislocation
(at acute 18months pre presentation)

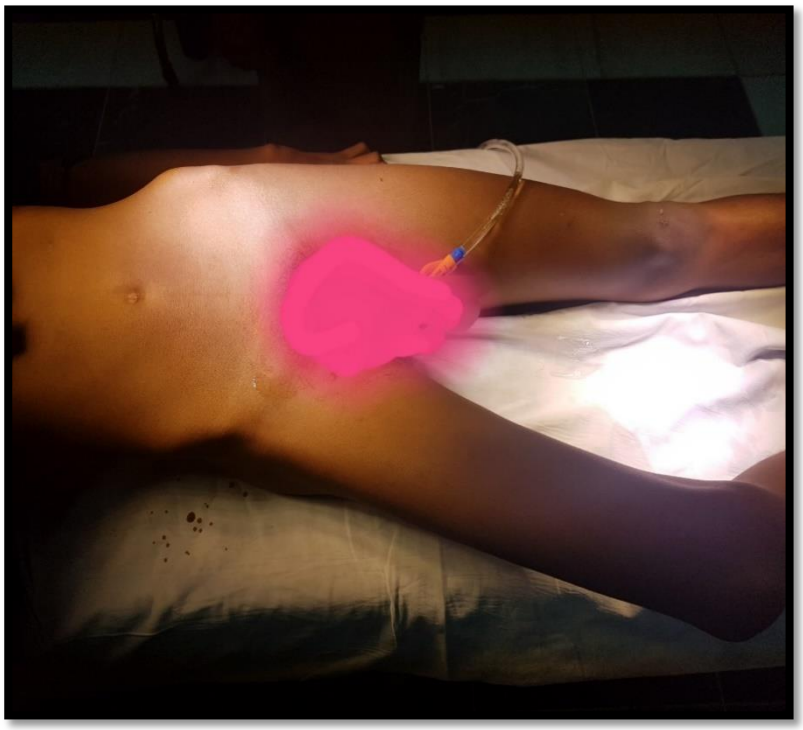


Case 3 At first OPD visit

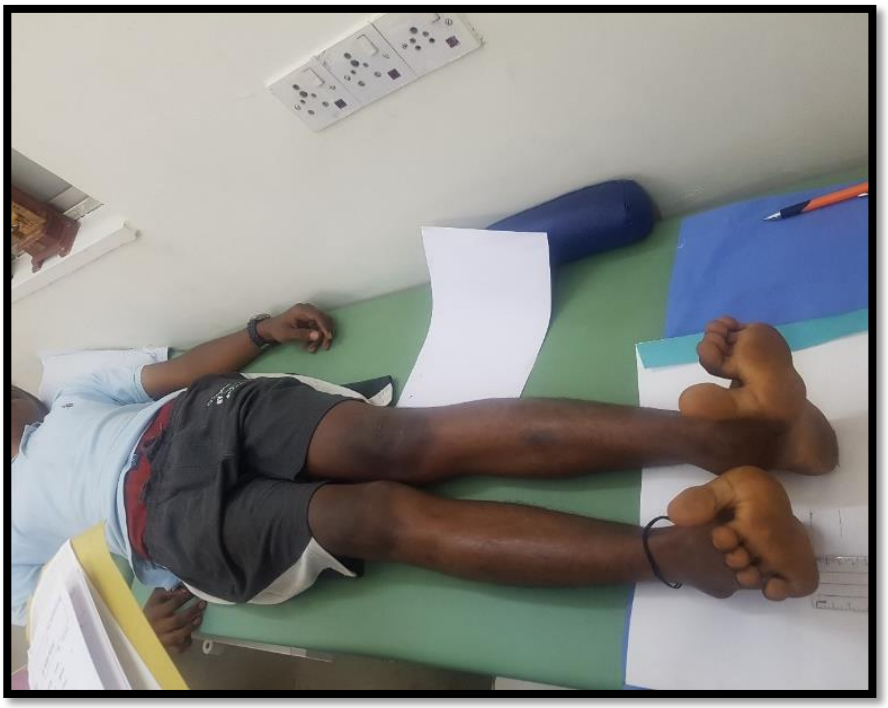




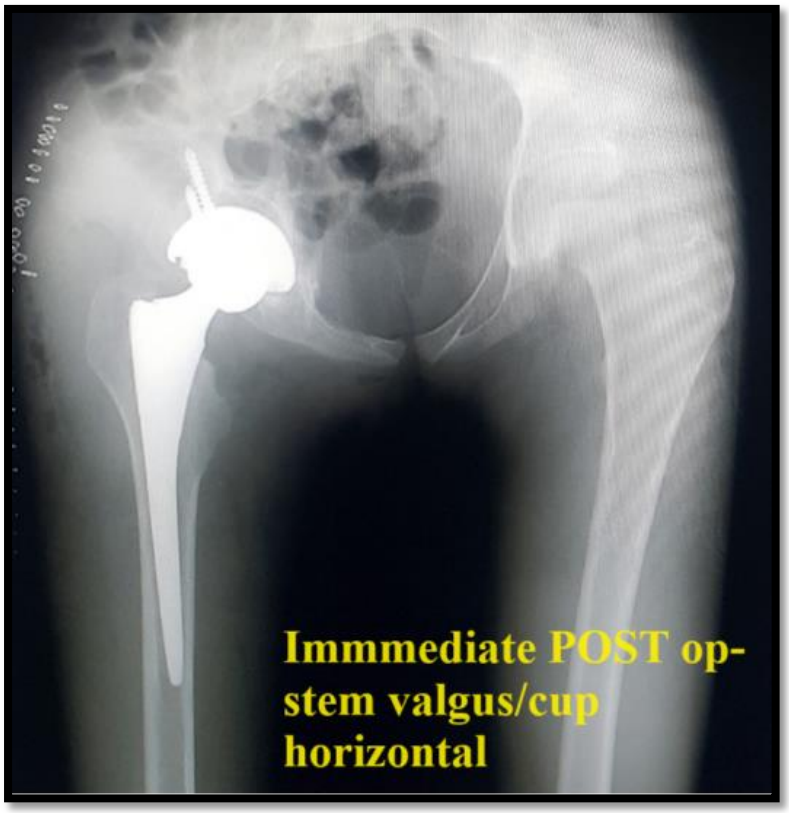
Case 3 Clinically FFD > 30/ABD & ER fixed deformity right hip with LLD (Shortening)



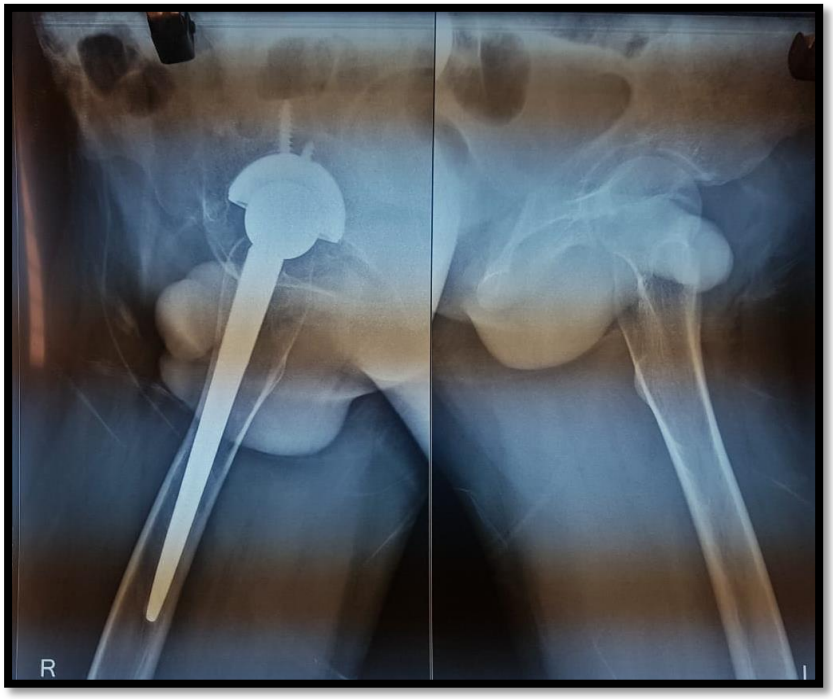
CASE 3 Post OP FFD Corrected

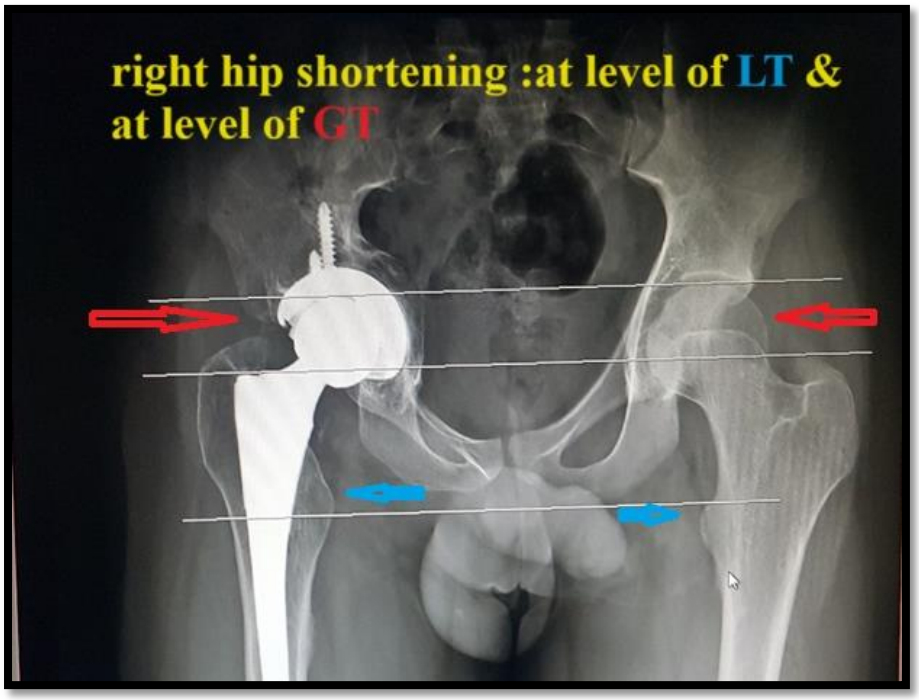


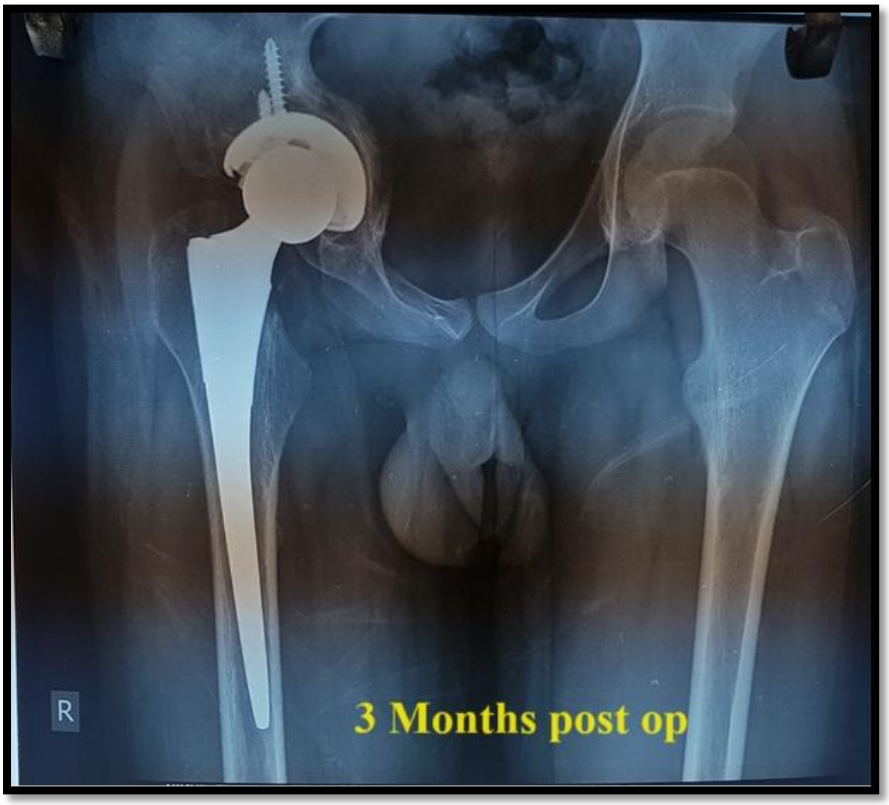

OPERATED right side with POST OP
LLD of 2CM (correction of 4-2 = 2cm)

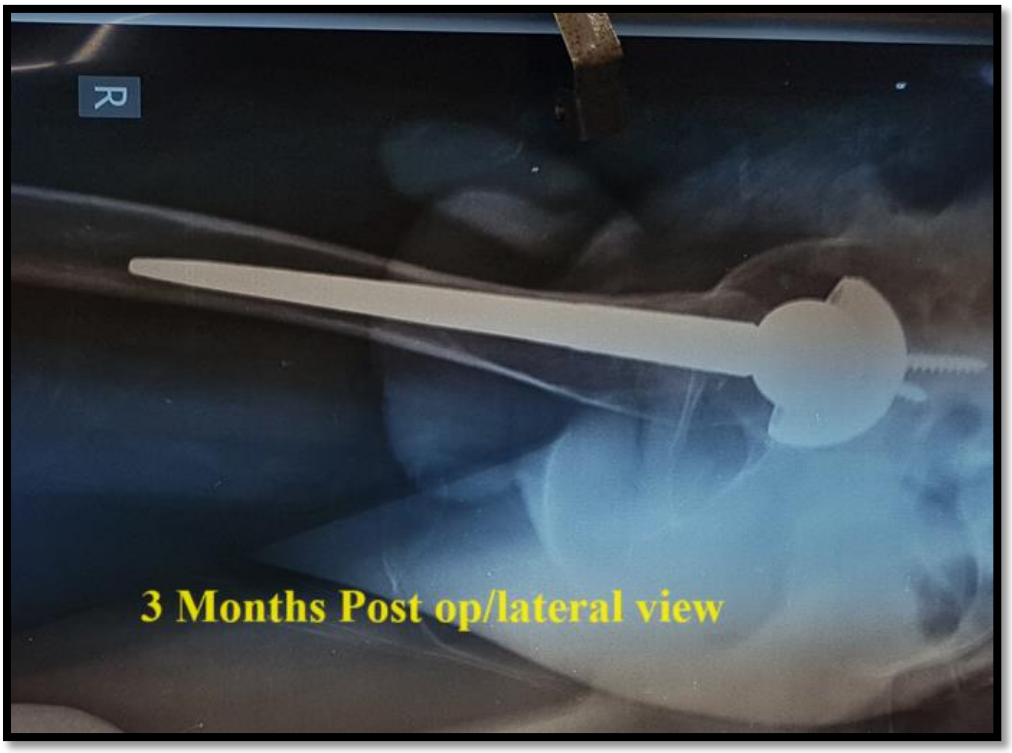


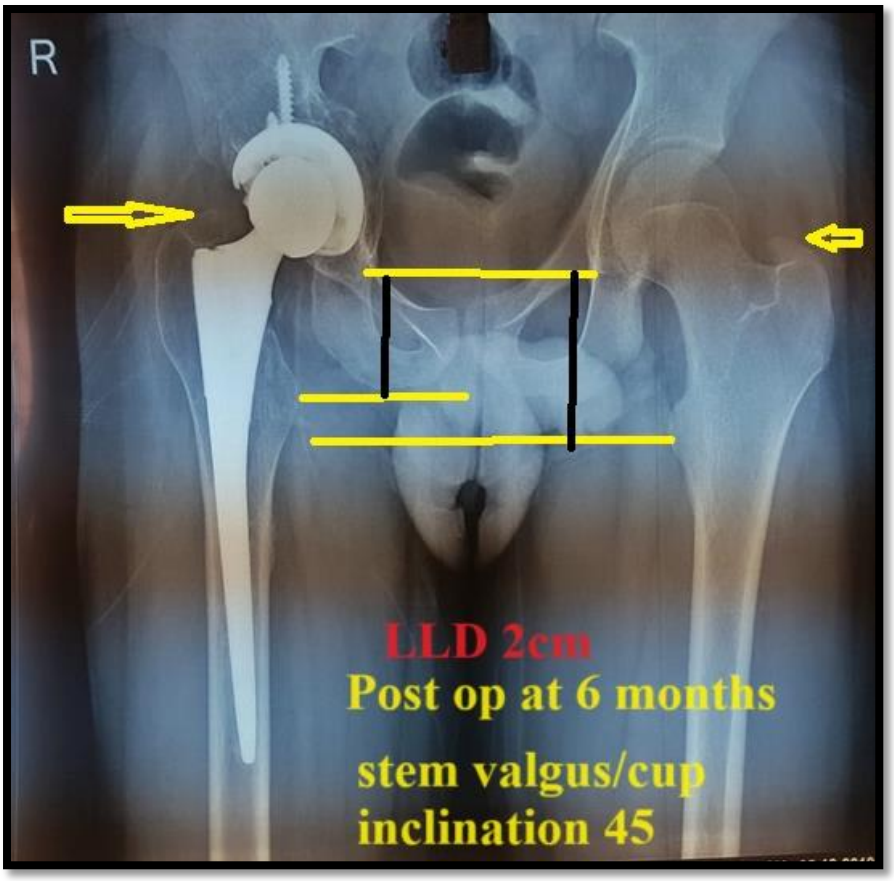
CASE 3 Immediate POST OP

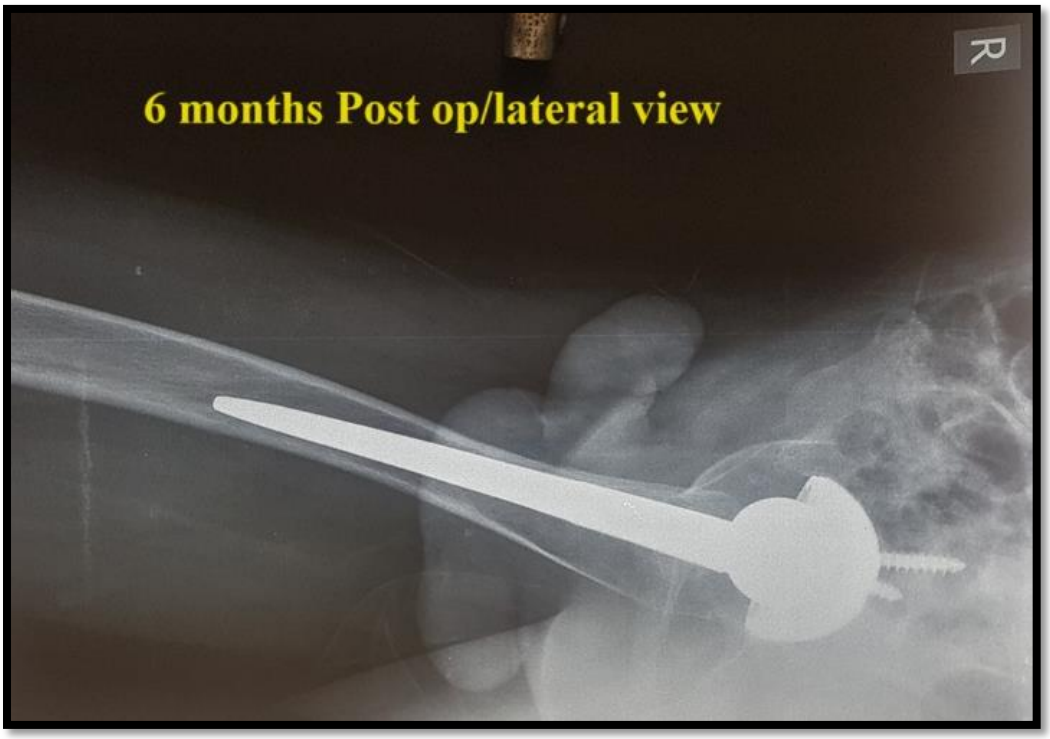



right hip shortening :at level of LT &
at level of GT

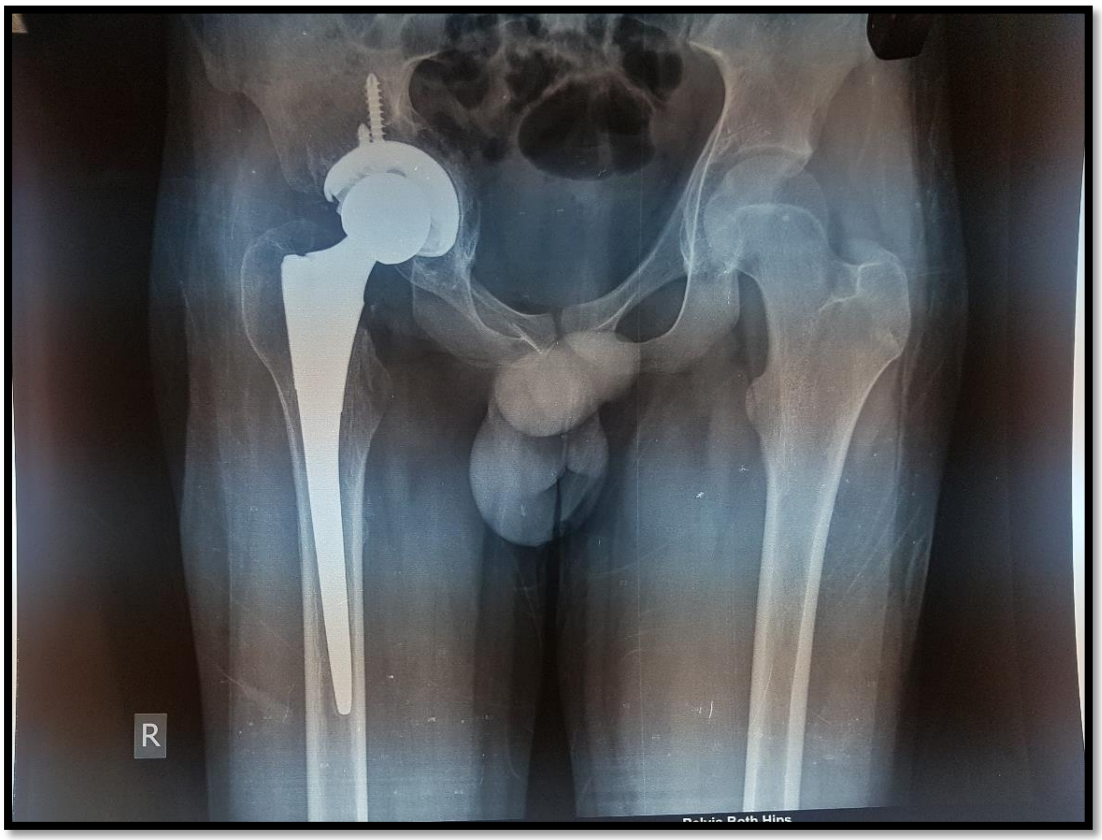

R
3 Months post op


R
3 Months Post op/lateral view


R
LLD 2cm
Post op at 6 months
stem valgus/cup
inclination 45



CASE 3 6 Month POST OP



ANNEXURE - E - LIST OF PUBLICATIONS/PRESENTATION

European Journal of Molecular & Clinical Medicine
ISSN2515-8260 Volume 10, Issue 01, 2023

A prospective clinical study of Limb Length Discrepancy in THR using lateral surgical approach

[1]Dr. Sarang Shete, [2]Dr. Kiran Patil, [3]Dr. S K Saidapur, [4]Dr. Sandeep Chauhan

[1]Assistant Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India
[2]Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India
[3]Associate Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India
[4]Senior Consultant and Joint Replacement Unit Head, Artemis Hospitals, Gurgaon, Haryana, India

Corresponding Author:
Dr. Sarang Shete

Abstract

Total Hip Replacement surgery is a common surgery in end stage hip arthritis. Limb Length Discrepancy (LLD) in THR is an inevitable complication if not in all but few certain patients with THA. Also, it is an Important yet least studied aspect as a complication following this surgery. Hence to, understand the factors which cause & influence this condition, this study was conducted with an objective to know the implications of clinical parameters like hip movements & their range of motions, preoperative limb length measurements of affected arthritic hips & change in limb length after Total hip replacement surgery. Moreover LLD studies in Indian patients are very few.

This Study included 36 Total hip replacement surgeries from 34 patients (with 2 patients having bilateral involvement). Standard lateral surgical approach was used in all the patients. Most common cause of pathology affecting the hip arthritis was AVN (osteonecrosis) of hips[3]. The definitive difference between preoperative and post-operative limb length was noted. Change in LLD from preoperative to postoperative interval was significant with p-value of 0.001 so the groups had a highly significant difference in LLD measurement. The change in all the movements of operated hips showed a gradual increase in further follow-ups and flexion component having better improvement in range of motions. Average Preop LLD of 15 mm was found and post-op, the median LLD noted was just 5mm which signifies good improvement.

Keywords: Total hip replacement, limb length discrepancy

European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 **Volume 10, Issue 02, 2023**

Original Research Article

Outcome assessment of total hip arthroplasty patients with limb length discrepancy

[1]Dr. Sarang Shete, [2]Dr. SK Saidapur, [3]Dr. Ravi Jatti, [4]Dr. Kiran Patil

[1]Assistant Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India
[2]Associate Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India
[3]Professor and HOD, Department of Orthopaedics, Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India
[4]Professor and HOD, Department of Orthopaedics, Jawaharlal Nehru Medical College, KLE Academy of Higher Education and Research (KAHER), Belagavi, Karnataka, India

Corresponding Author:
Dr.Sarang Shete

Abstract

THA is a successful orthopaedic intervention & the procedure has relieved pain of many patients, yet some of them remain unsatisfied & has some complications which has least mortality but could have quite reasonable discomfort, especially in initial rehabilitation periods. Difference in the limb length is one among them & this LLD (limb length discrepancy) can persist permanently in these few. Understanding this effect on patients satisfaction is an important aspect.

Thus, in this research we aimed at understanding the outcome of THA patients assessed by using PROM-Patient reported outcome measurement tools like Harris Hip score (HHS) & X-Ray based measurements of change in LLD before & after surgery.

In this prospective study of 6 months follow up of each individual patients of uninfected aetiology & patients above 18 years of age irrespective of gender, we studied 45 hips in total 42 patients. All of them underwent Total Hip Replacement for various reasons of painful end stage arthritis or fractures of hips, with one third young patients having age less than 40 years.

In terms of negative results, only one THA was restored to same LLD from preop to post op (i:e 0 mm to 0 mm-zero to zero) as compared to other 44 Total hips, where change in LLD was observed as inevitable event in a range from 0 to 40 mm LLD in preoperative restored to range of 0 to 20 mm of LLD in the post operative period.

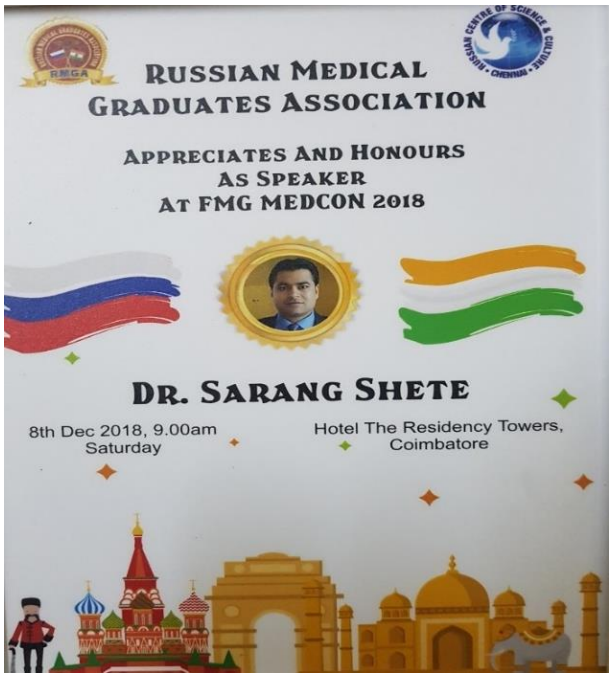
Keywords: Total hip arthroplasty, LLD, harris hip score, outcome, PROM

Introduction

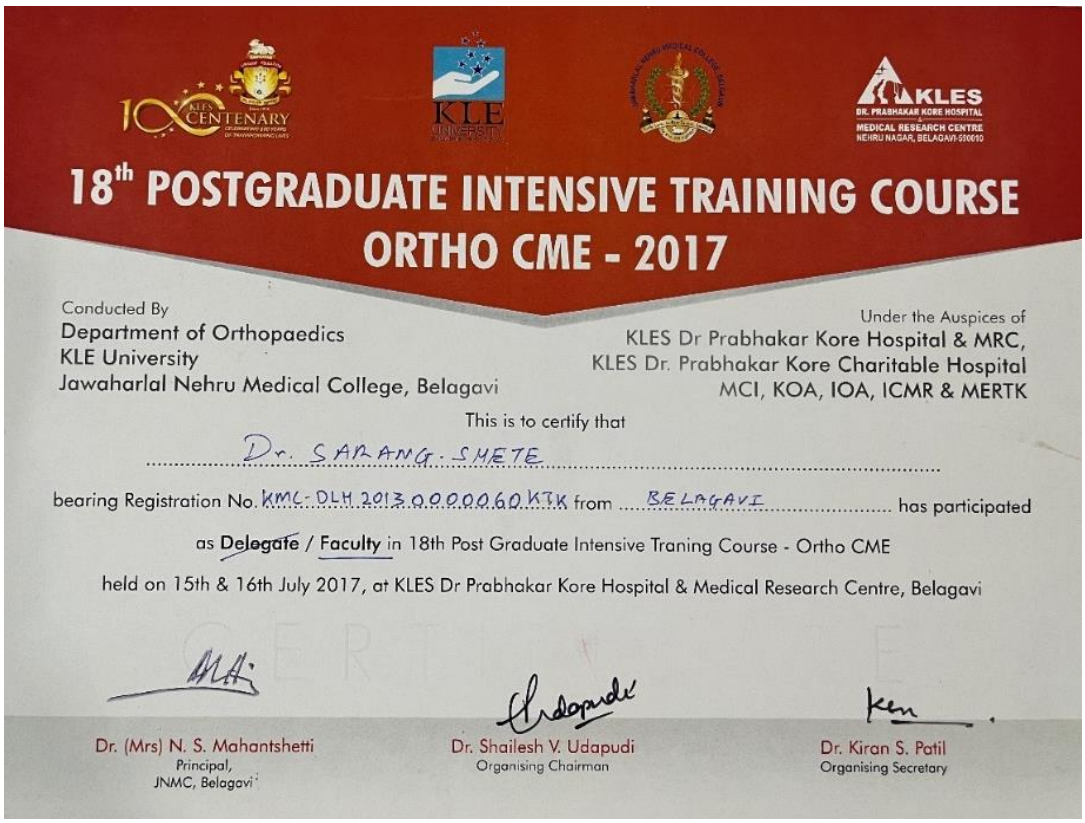
THA or Total Hip Arthroplasty surgery is a proven procedure in achieving pain relief in end stage arthritis & very popular surgery for last 7 decades since Prof Charnley published his result in Lancet in 1960s [1]. The various reasons of end stage arthritis are posttraumatic fractures of the femoral neck & acetabulum. Osteoarthritis of hips due to other causes called secondary OA where hips are affected with disabling diseases like rheumatoid arthritis & ankylosing spondylitis & recent entities like osteonecrosis of hips causing collapse of femoral heads secondary to various causes like alcoholism or steroidal therapies during covid pandemics or any of the causes for steroidal usage like skin diseases, asthmatics or nonspecific idiopathic avascular necrosis of hip [2, 3].

PRESENTATIONS

1. "Arthritis of hip in Young & Total Hip Replacement" at "Russian Medical graduates association's 2nd Annual conference on 8th December 2018. at Coimbatore. Tamilnadu.



2. topic <u>LLD in complex THA in Moscow.Russia.Europe.</u>



18th POSTGRADUATE INTENSIVE TRAINING COURSE
ORTHO CME - 2017

Conducted By
Department of Orthopaedics
KLE University
Jawaharlal Nehru Medical College, Belagavi

Under the Auspices of
KLES Dr Prabhakar Kore Hospital & MRC,
KLES Dr. Prabhakar Kore Charitable Hospital
MCI, KOA, IOA, ICMR & MERTK

This is to certify that

Dr. SARANG. SHETE

bearing Registration No. KMC-DLH 2013 0000060 KTK from BELAGAVI has participated

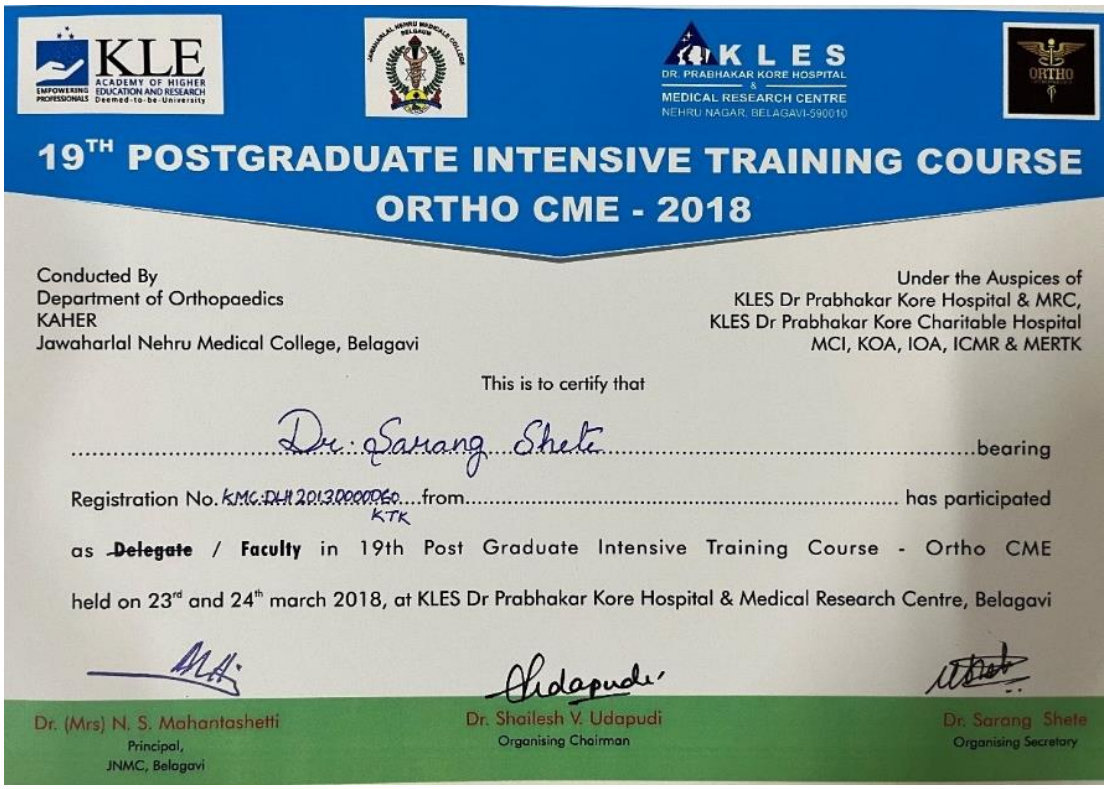
as ~~Delegate~~ / Faculty in 18th Post Graduate Intensive Traning Course - Ortho CME

held on 15th & 16th July 2017, at KLES Dr Prabhakar Kore Hospital & Medical Research Centre, Belagavi

Dr. (Mrs) N. S. Mahantshetti
Principal,
JNMC, Belagavi

Dr. Shailesh V. Udapudi
Organising Chairman

Dr. Kiran S. Patil
Organising Secretary



19TH POSTGRADUATE INTENSIVE TRAINING COURSE
ORTHO CME - 2018

Conducted By
Department of Orthopaedics
KAHER
Jawaharlal Nehru Medical College, Belagavi

Under the Auspices of
KLES Dr Prabhakar Kore Hospital & MRC,
KLES Dr Prabhakar Kore Charitable Hospital
MCI, KOA, IOA, ICMR & MERTK

This is to certify that

Dr. Sarang Shete bearing

Registration No. KMC-DLH 2013 0000060 KTK from has participated

as ~~Delegate~~ / **Faculty** in 19th Post Graduate Intensive Training Course - Ortho CME

held on 23rd and 24th march 2018, at KLES Dr Prabhakar Kore Hospital & Medical Research Centre, Belagavi

Dr. (Mrs) N. S. Mahantashetti
Principal,
JNMC, Belagavi

Dr. Shailesh V. Udapudi
Organising Chairman

Dr. Sarang Shete
Organising Secretary

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH Deemed-to-be-University

KLES PRABHAKAR KORE HOSPITAL & MEDICAL RESEARCH CENTRE

CERTIFICATE

POSTGRADUATE INTENSIVE TRAINING COURSE - ORTHO CME

Conducted by
DEPARTMENT OF ORTHOPAEDICS
KAHER

Jawaharlal Nehru Medical College Belagavi & KLES Dr. Prabhakar Kore Hospital & MRC-Belagavi
On 29th & 30th March 2019

Under the Auspices of

KAHER, KLES Dr.Prabhakar Kore Hospital & MRC, IOA - KOA, Medical Education & Research Trust Karnataka, Medical Council of India & ICMR

This is to Certify that

Dr. SARANG. SHETE With Registration No. KMC·DLH 20130000060 KTK has participated as ~~Delegate~~/Faculty in **Orthopaedic CME -20th Post Graduate Intensive Training Course** held on 29th & 30th March -2019 at KLE Dr. Prabhakar Kore Hospital & MRC, Belagavi

Dr.Puneet Chamakeri
Organisng Jt. Secretary

Dr.R.B.Uppin
Organising Secretary

Dr.Shailesh V. Udapudi
Organising Chairman

Dr.N.S.Mahantshetti
Principal, JNMC

RMGA

3rd FMGMEDCON MADURAI 2019

INTERNATIONAL MEDICAL CONFERENCE

Participation Certificate

This is to certify that Dr. Sarang. Shete *has Participated in the FMGMEDON 2019 International Medical Conference as a ~~Deligate~~ / Faculty conducted at Courtyard by Marriott, on 10.08.2019 Madurai.*

Dr.BABU GANESH
President RMGA

Dr.CHANDRAN
Organizing Chairman

Dr.SUNDRA MAHALINGAM
Organizing Secretary

Dr.ARIVARASAN
Scientific Secretary

Tamilnadu Medical Council has Granted 5 Credit hours of Accredition
The Tamilnadu Dr.M.G.R Medical University has Granted 10 Credit Points of Accredition.

SHRI DHARMASTHALA MANJUNATHESHWARA UNIVERSITY

INTERNATIONAL CONFERENCE ON BIOMEDICAL AND CLINICAL RESEARCH
Organized by
Shri Dharmasthala Manjunatheshwara University
in association with
Association of Pharmaceutical Research

CERTIFICATE

This certificate is awarded to

Mr./Mrs./Ms./Dr. Dr.SARANG SHETE

for being the **Committee Member**
in the **International Conference on Biomedical and Clinical Research**
held on 21st to 22nd of November 2022
at Shri Dharmasthala Manjunatheshwara University, Dharwad, Karnataka

APR ASSOCIATION OF PHARMACEUTICAL RESEARCH

Organising Secretary ICBMCR 2022 | Founder & CEO APR | Chairperson ICBMCR 2022 | Registrar SDM University | Vice Chancellor SDM University

PAPER / POSTER PARTICIPANT CERTIFICATE

KOACON 2023 BELAGAVI

This is to certify that

Dr. SARANG. SHETE bearing medical reg. No. DLH 20130000 60KTK

Has presented PAPER / ~~POSTER~~

titled "LLD in Total Hip Replacement"

at the KOACON 2023 held on
3rd, 4th and 5th of February 2023 at Belagavi.

Dr. Shailesh V Udapudi, Organising Chairman, KOACON 2023
Dr. Anil B Patil, Organising Secretary, KOACON 2023
Dr. Rajendra Bhandankar, Scientific Chairman, KOACON 2023
Dr. Hemanth Koujalgi, B.O.S.S. President

KOACON 2023 BELAGAVI

WORKSHOP PARTICIPANT CERTIFICATE

Certificate of Recognition

presented to

Dr. SARANG SHETE

for participating as the CHAIRPERSON at the KOACON 2023 held from 3rd - 5th of February 2023 at JNMC Centenary Convention Centre, Belagavi.

Dr. Shailesh V Udapudi
Organising Chairman
KOACON 2023

Dr. Anil B Patil
Organising Secretary
KOACON 2023

Dr. Rajendra Bhandankar
Scientific Chairman
KOACON 2023

Dr. Hemanth Koujalgi
B.O.S.S. President