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*“A CROSS SECTIONAL STUDY OF AGE RELATED  
PUBIC SYMPHYSEAL CHANGES IN 3<sup>RD</sup> AND 4<sup>TH</sup>  
DECADES OF LIFE”*

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By

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**ABSTRACT****Background and objectives –**

Age estimation is one of the most important and essential exercise for personal identification in dead bodies. Studies have shown age specific changes in pubic symphyseal surface between 2<sup>nd</sup> – 5<sup>th</sup> decade of life; prominent during 3<sup>rd</sup> & 4<sup>th</sup> decades & considered much more reliable for determining the age. It can give a narrow age range when compared to other parameters such as dental changes, suture closure of skull, changes in the other bones like vertebra, ribs, etc. The objective of the study is to estimate age based on the morphological changes by applying the standard criteria devised by Mckern and Stewart, compare the data from different studies and its usefulness in application to the people of North Karnataka region.

**Methods –**

The present study is a cross sectional study of one year duration from 1<sup>st</sup> November 2007 to 31<sup>st</sup> October 2008. A total of 50 pubic bones (37 males and 13 females) aged between 20-40 years were collected from the bodies of deceased at post mortem done in mortuary of department of forensic medicine and toxicology. After collecting the pubic bones serial numbers were given and kept for natural maceration for 3-4 weeks. It was then washed and the changes observed in the pubic symphyseal surface and compared to other researches done in India and abroad.

**Results –**

For males belonging to North Karnataka region, after adding +1 and +2 years for the total score 6-7 and 10 respectively, morphological changes in pubic

symphyseal surface found accurate for age estimation. For females, the age range was high in the total scores 6-7 (22-35 years) and total score 10 (30 years) compared to Mckern and Stewarts' total score 6-7 (20-24 years) and total score 10 (23-28 years).

**Conclusions and interpretation –**

The present study revealed that the age can be fairly accurately estimated from the pubic symphyseal surface in males of North Karnataka region using Mckern and Stewart's method. On comparing to other researches in South India (Hyderabad) it is found to be correlating for males. On comparing to the studies done in North India it is less accurate to be used for females but can be fairly accurately used in males. Overall, Mckern and Stewart's criteria of age estimation from pubic symphysis bone has found more accurate when applied to male bones.

**Key words** - Mckern Stewart's criteria, age estimation, pubic symphysis.

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## INTRODUCTION

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The establishment of identity of an individual is of immense medico legal significance both in the living and dead. The simplest and frequently used method for identification of a human dead body is personal recognition by close relatives. But in cases where a dead body is of unknown origin from mass disasters, fires, explosions, aircraft accidents, murders or mutilated remains in an advanced stage of decomposition where only the skeleton or fragments of skeleton are available, only the skeletal examination can lead to a reliable determination of personal identification.

Forensic medicine specialists are very often faced with the problem of fixing the individuality of unknown human body. The bones are the most durable and relatively indestructible structures of the body. They have abundance of information in them as they resist putrefaction to a great extent. Therefore, when entire skeleton is available, a complete identity may be established from determination of age, sex, stature, race, dental details, superimposition technique of skull etc. But if only skeletal fragments are available, a partial identity may be established by the determination of age, sex, stature etc. A lot of methods are available that help us in assessing age from bones. The result comes in ranges and these ranges are wide after 2<sup>nd</sup> decade of life.<sup>1</sup>

Ideally, a method for skeletal age determination must be reliable, simple and applicable to all age groups. Unfortunately, such an ideal method still remains a dream for the anthropologists too. All the present methods lack one or more of the above requirements.

To determine age after second decade of life, the data suggested by Gustafson from dental examination is a task of an expert and requires the help of a Forensic Odontologist. Microscopic examination of the internal structure of bone is not a

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simple method and, at present, it is not suitable for routine medico-legal work. Ectocranial suture closure is highly variable and is only broadly correlated with age after 2<sup>nd</sup> decade.<sup>2</sup>

The metamorphic changes in the pubic symphysis have been found to be one of the best means of age determination during this period. It is highly relied upon by forensic anthropologists. Anthropologists who frequently deal with fragmentary remains use this bone as it is most often recovered intact in the skeletal remains. In a study in (1997) on canid scavenging, the innominates were recovered in 60 to 79% of the cases. According to this model of scavenging patterns, the lower extremities, including the innominates, are generally not removed until stage 2 of decomposition. Also it seems relatively rare for a scavenger to damage the pubic symphysis, making them suitable to be used for age estimation.<sup>3</sup>

When the changes in the pubic symphysis are correlated with other skeletal criteria, Krogman ventures estimation of age with an accuracy of  $\pm 2$  years.

Even when other ageing criteria are available, reliable age estimation can be made by using this method alone as it is the most reliable single skeletal event in the adult human skeleton. Because of the tested reliability of the symphyseal surface, the use of other ageing criteria is necessary only when the symphyseal face is damaged or missing, at least for age groups over 17 years.

Considerable studies have been done on the use of pubic symphyseal surface as a tool for age indicator since 1920 (Todd). Most of these studies, or to say all, have strengthened the usefulness of pubic symphyseal surface as an age indicator.

## **INTRODUCTION**

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There have been certain variations in studies done in different parts of the world. No such study has been done earlier in North Karnataka region of India. Therefore we felt the need to conduct such a study so that usefulness of this indicator can be compared with data available to either substantiate or refute the use of this indicator for age estimation.

Studies have shown age specific changes in pubic symphyseal surface between 2<sup>nd</sup> – 5<sup>th</sup> decade of life; prominent during 3<sup>rd</sup> & 4<sup>th</sup> decades & considered much more reliable for determining the age.

It can give a narrow age range when compared to other parameters such as dental changes, suture closure of skull, changes in the other bones like vertebra, ribs, etc.

### THE AIM OF THE STUDY

- ❖ To correlate the age from symphysis pubis changes using Mckern and Stewart criteria.

### THE OBJECTIVES OF THE STUDY

- 1) To observe the morphological changes those occur in the symphysis pubis of 20-40 years of age groups in males and females.
- 2) To estimate age based on the morphological changes by applying the standard criteria devised by Mckern and Stewart.
- 3) Compare the data from different studies.
- 4) Usefulness of its application to the people of North Karnataka.

### ANATOMY

The innominate or hip bone is large, irregular bone, constricted centrally and expanded above and below. Its lateral surface has a deep, cup-shaped acetabulum, articulating with the femoral head, anteroinferior to which is the large, oval or triangular obturator foramen. Above the acetabulum, the bone widens into a plate with a sinuously curved iliac crest. Hip bone articulates in front with its fellow to form the pelvic girdle. Hip bone has three parts, ilium, ischium and pubis connected by cartilage in youth but united as one bone in adults. The principal union is in the acetabulum. The ilium includes the upper acetabulum and expanded area above it; the ischium includes the lower acetabulum and bone posteroinferior to it; the pubis forms the anterior acetabulum, separating the ilium from ischium and the anterior median region where the pubes meet.<sup>4</sup>

The pubic symphysis is the joint formed by the articulation of the pubic portion of the right and left innominate bones. The word 'symphysis' is derived from Greek which mean "growing together". A symphysis is defined as lightly movable joint in which the bones are joined by a fibro cartilage. This definition is somewhat lacking, as "hyaline cartilage" is also present in the form of articular cartilages on its bony surfaces.<sup>5</sup>

### STRUCTURE

The thicker parts of the hip bone consist internally of cancellus bone enclosed between two layers of compact bone; the thinner parts are composed of entirely of compact bone.

### DEVELOPMENT OF HIP BONE

The hip bone is ossified from eight centres. Three primary centres, one each for the ilium, ischium and pubis and five secondary centres.

#### PRIMARY CENTRES

The centre for the ilium appears immediately above the greater sciatic notch at about 8<sup>th</sup> week of intrauterine life. The centre for ischium appears in the body at 4<sup>th</sup> month and for the pubis in the superior ramus between 4<sup>th</sup> and 5<sup>th</sup> months. At birth these parts of the hip bone are still cartilaginous.

The acetabulum is a cartilaginous cup with triradiate stem extending medially from its deep aspect to appear on the pelvic surface as a “Y” shaped epiphyseal plate between the ilium, ischium and pubis. This cartilage also includes the anterior inferior iliac spine. The strip of the cartilage along the inferior margin of the hip bone covers the surface of the ischial tuberosity temporarily. The full conjoined rami of the ischium and pubis is thin and continues to the symphyseal surface of the pubis and then along the pubic crest to the pubic tubercle. The ossifying ischium and pubis fuse to form the conjoined bony ramus at 7<sup>th</sup> or 8<sup>th</sup> year.

#### SECONDARY CENTRES

The secondary centres appear at puberty and join the rest of the bone between 15<sup>th</sup> to 25<sup>th</sup> years. These are usually two secondary centres for the iliac crest, but they rapidly fuse with one another. Ossification of acetabular cartilage begins as two separate centres known as acetabulli between the ilium and the pubis and between the ilium and the ischium. These two centres fuse and form a single centre which forms the substantial part of the articular surface of the adult bone. The anterior inferior iliac

spine may ossify from separate centre and as an extension of the above centre. The cartilage around the inferior margin of the bone begins to ossify over the ischial tuberosity and ossification spreads forward. The part which ossifies first fuses almost at once and the fusion extends forward. The pubic tubercle, crest and the symphyseal surface of the pubic bone may have a separate centre.

### **PUBIS**

The pubis is the anterior part of the innominate bone and forms a median cartilaginous pubic symphysis with that from the other side. From its anteromedial body, the superior ramus passes above and backwards to the acetabulum and inferior ramus passes backwards, downwards and laterally to join the ischial ramus inferomedial to the obturator foramen.

The body is is anteroposteriorly compressed, consists of anterior, posterior and symphyseal (medial) surfaces with an upper border, the pubic crest. The anterior surface also faces inferolaterally; it is rough superomedially and smooth elsewhere, giving attachment to medial femoral muscles. The smooth posterior surface faces upwards and backwards as the oblique anterior wall of the lesser pelvis and is related to the urinary bladder. The symphyseal surface is elongated and oval, united by cartilage with fellow of opposite side at the pubic symphysis. The pubic crest is the rounded upper border of the body which overhangs the anterior surface. Its lateral end is the rounded and called pubic tubercle. Both crest and tubercles are palpable, the later partly obscured in males by the spermatic cord that crosses above it from the scrotum to the abdomen.

The anterior surface of the pubic body faces the femoral adductor region. The anterior pubic ligament attaches to its medial part and to a rough strip, which is wider

in females. The posterior surface is separated from the urinary bladder by retropubic fat.

### **SUPERIOR PUBIC RAMUS**

The superior pubic ramus passes upwards, backwards and laterally from the body, superolateral to the obturator foramen, to reach the acetabulum. It is triangular in section and has three surfaces. Its anterior, pectineal surface, tilted slightly up, is triangular in outline and extends from the pubic tubercle to the iliopubic eminence. It is bounded in front by the rounded obturator crest and behind by the sharp pectin pubis (pectineal line) which, with the crest, is the pubic part of the linea terminalis (i.e. anterior part of the pelvic brim). The postero- superior pelvic surface is medially inclined which is bounded above by the pectin pubis and below by a sharp inferior border. The obturator surface is directed downwards and backwards and is crossed by the obturator groove sloping downwards and forwards. Its anterior limit is the obturator crest and its posterior limit is the inferior border.

### **INFERIOR PUBIC RAMUS**

The inferior pubic ramus, an inferolateral process of the body, descends inferolaterally to join the ischial ramus medial and below the obturator foramen. The union may be locally thickened, but not obviously so in adults. The ramus has two surfaces. The anteroexternal surface continuous above with that of the pubis faces the thigh and is marked by muscles. It is limited laterally by the margin of the obturator foramen and medially by the rough anterior border. The posterointernal surface is continuous above with that of the body and is transversely convex: its medial part is often everted in males and gives attachment to the crus penis. This surface faces the perineum medially and its smooth lateral part tilted up towards the pelvic cavity. The

internal surface is indistinctly divided into medial, intermediate and lateral areas. The medial area faces inferomedially and is in direct contact with the crus penis or clitoris which is limited above and behind by an indistinct ridge for attachment of the fascia overlying the superficial perineal muscles. The medial margin of the ramus is strongly everted in males and provides attachment for the fascia lata and the membranous layer of the superficial perineal fascia.

### **PUBIC TUBERCLE**

The pubic tubercle provides a medial attachment for the inguinal ligament in the floor of the superficial inguinal ring and is crossed by the spermatic cord.

### **PECTEN PUBIS**

The pecten pubis is the sharp superior edge of the pectineal surface. The conjoint tendon and lacunar ligament are attached at its medial end. A strong fibrous pectineal ligament is attached along the rest of its surface. The smooth pelvic surface is separated from parietal peritoneum only by areolar tissue in which the lateral umbilical ligament descends forwards across the ramus and laterally the vas deferens passes backwards. The obturator groove is converted to a canal by the upper borders of the obturator membrane and obturator muscles which transmit the obturator vessels and nerve from the pelvis to the thigh. Some fibers of the pubofemoral ligament are attached to the lateral end of the obturator crest.<sup>4</sup>

### AGE RELATED CHANGES:-

The changes in the structure of the pubic symphysis brought about by increasing age was described (1976) after examining 87 male and 111 female symphysis pubis by multiple microscopic sections.

According to this study, symphysis pubis undergoes a variety of changes under the influence of age and function. The symphysis pubis was started as a synchondrosis which usually changed into hemi-arthritis and occasionally developed into a real diarthrodial joint. The changes as described by this study are-

#### 1. THE SYMPHYSEAL CLEFT-

A median cleft in the posterior, superior portion begin to develop in the second year of life and is mostly presented after two years of age. This coincides with the increased shearing stresses on the symphysis due to assumption of upright gait accompanied by increased body weight. It showed cleft in 75% of males and 80% of females before 16years; and 88% of adult males and 97% of adult females. The majority of the clefts were superior, posterior and mid line and are termed as primary clefts. The secondary clefts which take at least in part, an eccentric course between the hyaline cartilage covering the pubic bone and the fibrous cartilage forming the symphyseal disc are traumatically modified clefts and are much more common in females than in males.

Complete clefts transecting the symphyseal cartilage from posterior to anterior ligaments were present in majority of adult females when compared to adult males. The clefts of any type were longer in females and diarthroidal transformation were seen twice as often in females as in males.

### 2. THE OSTEO CARTILAGINOUS BORDER-

In the new born and up to the end of the second year, the osteo-cartilaginous border was smooth and concave laterally. After this age microscopic irregularities begin to develop at the ossification zone, leading to grossly recognizable interdigitations between cartilage and bone after four years of age. These cartilaginous projections were arranged as 8 to 12 transverse ridges which slightly diverge from posterior towards the anterior on the symphyseal facet. These interdigitations were clearly visible until about 21 years of age and slowly level out with the termination of growth at 23 – 25 years. These changes represented an adaptation of pubic symphysis to the increasing sharing forces. The appearance and slow disappearance of bony grooves and ridges, corresponding to the indentations of growth cartilage, plays an important role in the anthropological ageing methods.

### 3. THE RETROPUBIC EMINENCE-

It is a palpable and visible bulge over the pelvic aspect of the pubic symphysis. It is always absent in childhood and adolescence. It appears in females in relationship to pregnancy and parturition. The size of the eminence in multiparous female was averaged 8mm in transverse and 4mm in vertical dimension and may be pronounced in child bearing age. In males, the retropubic eminence develops later, less frequently, smaller and partly of a differentiated structure, appears after 35 to 40 years with dimensions of 4mm in width and 2 mm in height.<sup>6</sup>

### 4. AGE CHANGES INDEPENDENT OF PARTURITION-

In males and nulliparous females the symphyseal cleft often remains smaller. The persistent fibro cartilaginous disc becomes increasingly rigid. Not uncommon, invasion of the ageing fibro cartilage by blood vessels from the posterior ligaments from the osteo cartilaginous border is observed, leading to transformation of fibro cartilage into fibrous tissue.<sup>7</sup>

### 5. DEGENERATIVE ARTHRITIC CHANGES-

The development of degenerative arthritic changes depends on hypermobility due to formation of large symphyseal cleft. For that reason such changes are more common in ageing females than in males. There is no sharp border between post parturition changes and early arthritic manifestations. Because of limited mobility, compared with joints of the extremities, marginal lipping is relatively limited.

It is concluded that the progressive effacement of growth ridges and development of degenerative and arthritic changes are more continuously time related in male than in female. The upright gait puts the pelvis in a keystone position for weight bearing static and dynamic stresses, leading to age related degeneration changes in both sexes.<sup>6</sup>

Various researchers have observed and noted down changes in the pubic symphyseal surface since eighteenth century, which help in age estimation with fair accuracy. Significant work was done by Todd in middle of twentieth century, which was adopted by others to follow him.

Hunter W (1743) has described lipping of the dorsal symphyseal margin and ventral beveling during third decade.<sup>8</sup>

Aeby (1858) described the symphyseal face of the pubis as a more or less irregular convex surface rounded by an oval outline and of which the finer structural relations are largely lost in maceration of the specimen. He observed that marked changes have undergone by the symphyseal face with age, for he stated as a general law that with passing of the childhood, the variety irregularity of its form increases, but later in life it once more becomes a single smooth surface.<sup>9</sup>

Cleland J (1889) noted the appearance of the curved line which forms the lateral border of the ventral rampart, and used it as a rough sex and age criterion.<sup>10</sup>

Martin R (1914) gave directions for measuring height of bony symphysis without any indication that this can be done with accuracy only in pelvis, which have reached the age of 35years.<sup>11</sup>

Todd (1920) was responsible for the early fundamental and significant contribution on the pubic symphysis as a site suitable for age determination.<sup>12</sup> His collection was originally named as Western Reserve University Collection. But now it is named as The Hamman – Todd Collection which is present in Department of Anthropology, Cleveland museum of natural history, Cleveland University.<sup>13</sup> Over a 25 year period, a total of 3592 cadavers from City Hospital, Lakeside Hospital, and Warrenville Hospital were autopsied, dissected and morphologically and photographically catalogued. At present 3422 of the original Todd collections are

housed in the Cleveland museum of natural history. Out of them 3157 specimens were reviewed to obtain test samples. It was observed that the symphyseal surface of the pubic bone undergoes a regular metamorphosis from puberty onwards and established age categories based upon these changes.

In principle Todd considered each pubic symphysis to possess a more or less oval outline with long axis supero-inferior; this oval has nine morphological features namely:

1. Ridges and furrows.
2. Dorsal margin.
3. Ventral beveling.
4. Lower extremity
5. Superior ossific nodule.
6. Upper extremity.
7. Ventral rampart
8. Dorsal plateau
9. Symphyseal rim

These are all descriptive osteological features. Varying and progressive combinations of these features resulted in the establishment of 10 phases of pubic symphysis, age ranging from 18-19 years to 50+ years. These phases as defined by him are:

### Ages And Description of Todd's Phases in Males

<b>Phase</b>	<b>Age in years</b>	<b>Description</b>
<b>I</b>	<b>18-19</b>	Symphyseal surface rugged, traversed by horizontal ridges separated by well marked grooves; no ossific nodules fusing with the surface; no definite delimiting margin; no definition of extremities
<b>II</b>	<b>20-21</b>	Symphyseal surface still rugged, traversed by horizontal ridges, the grooves between which are, however, becoming filled near the dorsal limit with a new formation of finely textured bone. This formation begins to obscure the hinder extremities of the horizontal ridges. Ossific nodules fusing with the upper symphyseal face may occur; dorsal limiting margin begins to develop, no delimitation of extremities; foreshadowing of ventral bevel.
<b>III</b>	<b>22-24</b>	Symphyseal face shows progressive obliteration of ridge and furrow system: commencing formation of the dorsal plateau; presence of fusing ossific nodules; dorsal margin gradually becoming more defined; beveling as a result of ventral rarefaction becoming rapidly more pronounced; no delimitation of extremities.
<b>IV</b>	<b>25-26</b>	Great increase of ventral beveled area; corresponding diminution of ridge and furrow formation: complete definition of dorsal margin through the formation of the dorsal plateau: commencing delimitation of lower extremity.

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- V**     **27-30**    Little or no change in symphyseal face and dorsal plateau except that sporadic and premature attempts at the formation of a ventral rampart occur; lower extremity, like the dorsal margin, is increasing in clearness of definition; commencing formation of upper extremity with or without the intervention of a bony (ossific) nodule.
- VI**     **30-35**    Increasing definition of extremities; development and practical completion of ventral rampart; retention of granular appearance of symphyseal face and ventral aspect of pubis; absence of lipping of symphyseal margin.
- VII**    **35-39**    Changes in symphyseal face and ventral aspect of pubis consequent upon diminishing activity; commencing bony out-growth into attachments of tendons and ligaments, especially the gracilis tendon and sacro-tuberous ligament.
- VIII**   **39-44**    Symphyseal face generally smooth and inactive; ventral surface of pubis also inactive; oval outline complete or approximately complete; extremities clearly defined; no distinct 'rim' to symphyseal face; no marked lipping of either dorsal or ventral margin.
- IX**     **45-50**    Symphyseal face presents a more or less marked rim; dorsal margin uniformly lipped; ventral margin irregularly lipped.
- X**      **>50**     Symphyseal face eroded and showing erratic ossification; ventral border more or less broken down; disfigurement increases with age.<sup>14</sup>

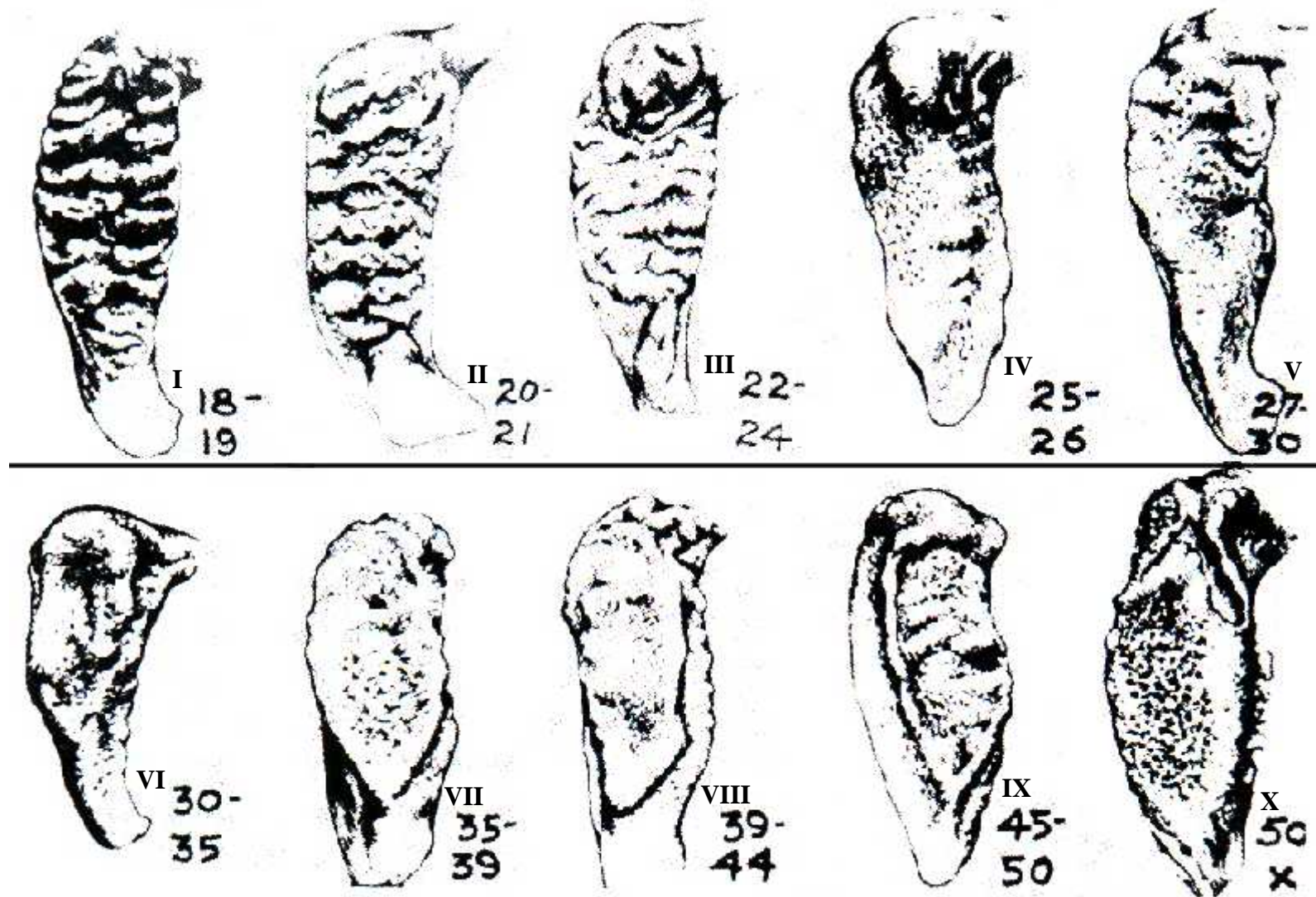


Fig.1 Modal Standards of Todd's X Typical Phases.

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Todd (further in 1921) evaluated pubic symphyseal surface separately on black males, white females, and black females to determine if race and sex affect the progression and appearance of age-related changes initially observed in white males. With regard to race, in (1921a: 26) concluded that, "race has strikingly little influence upon pubic metamorphosis".<sup>15</sup> Differences were noted for female specimens (1921b). Their stages of pubic metamorphosis were as much as ten years different from their stated age. The factors responsible for over ageing individuals in combined sex groups necessitated a separate standard for females. Hence, he developed accordingly a series of following ten phases for females.

### **Ages And Description of Todd Phases in Female**

<b>Phase</b>	<b>Age Range in years</b>	<b>Description</b>
<b>I</b>	<b>16-?</b>	Symphyseal surface rugged, traversed by horizontal ridges separated by well marked grooves, there being no distinction in size between the upper and the lower ridges and the whole pattern being more delicate than the male. No bony nodules fusing with the surface. No definite delimiting margin. No definition of extremities.
<b>II</b>	<b>?-25</b>	Symphyseal face still rugged. The horizontal grooves are becoming filled near their dorsal limit with new finely textured bone. Bony nodules fusing with upper symphyseal face. Dorsal delimiting margin begins to develop, no delimitation of extremities. Ventral bevel commencing.
<b>III</b>	<b>25-26</b>	Symphyseal face shows progressive obliteration of ridges and furrows. Commencing formation of dorsal plateau. Possible

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- presence of bony nodules. Dorsal margin becoming more defined and sharply lipped. Ventral bevel more pronounced. Extremities not delimited.
- IV 26-27 -** Great increase of ventral beveled area corresponding diminution of ridge and furrow formation. Complete definition of dorsal margin through the formation of the dorsal plateau. Commencing delimitation of lower extremity.
- V 27-30 -** Relatively small change in symphyseal face and dorsal plateau except for sporadic efforts at the formation of a ventral rampart. Dorsal margin increasingly clearly defined and more sharply lipped. Lower extremity forming with or without the intervention of a bony (epiphyseal) nodule.
- VI 30-36 -** Increasing definition of extremities. Development and practical completion of ventral rampart. Retention to a small degree of granular appearance of symphyseal face indicating that activity has not yet ceased. Failure of ventral aspect of pubis adjacent to ventral rampart to become transformed into a compact surface. Because of this, the rampart is more or less undermined. Retention of pectinate outline of the dorsal margin and in slight degree of ridge and furrow system. No lipping of ventral margin and no increased lipping of dorsal margin.
- VII 36-40 -** Slight changes in symphyseal face and marked changes in ventral aspect consequent upon diminishing activity. No formation of symphyseal rim. No ossification of tendinous

and ligamentous attachments. The lower age limit is approximate but the upper is more exactly defined by the material.

- VIII**    **40-45** - Symphyseal face and ventral aspect of pubic bone generally smooth and inactive. Oval outline complete. Extremities clearly defined. No distinct 'rim' to symphyseal face. No lipping of ventral or increased lipping of dorsal margin. Development of ossification in tendinous and ligamentous attachments especially those of sacrotuberous ligament and gracilis muscle.
- IX**      **45-50** - Symphyseal face presents a more or less marked rim. No lipping of ventral and no further lipping of dorsal margin. No secondary erosion or rarefaction.
- X**        **>50** - Ventral margin eroded to a great or less extent of its length, continuing somewhat into the symphyseal face. No increased lipping. Disfigurement only occasional and slight.<sup>16</sup>

Of these phases, Todd remarked that as a whole they were "a more reliable age indicator from 20 years to 40 than at the later ages." Further he suggested that the phases may be grouped into three periods:

<b>Phases</b>	<b>Periods</b>
<b>I – III</b> -	The Post – Adolescent stages
<b>IV-VI</b> -	The various processes by which the symphyseal outline is build up.
<b>VII-X</b> -	The period of gradual quiescence and secondary change. <sup>17</sup>

In 1930, he used radiography to investigate the pubic symphysis and described four phases related to age.

- a) **25 years** - Fine-texture body, undulating surface outline, no definition of extremities, no streak of compacta.
- b) **26-39 years** - Average – texture body, straight or faintly irregular surface outline, incompletely developed lower extremity, little or no grey streak of compacta.
- c) **40-55 years** - Average texture body, a straight or irregular ventral outline, a well developed lower extremity, and a fairly dense grey streak of compacta.
- d) **55+ years** - Open-texture body, an angular lower extremity, and a dense grey streak of compacta broken into patches marking the ventral margin.<sup>18</sup>

Todd suggested that really undulating outline with no definition of extremities and no grey streak of compacta with a finely textured body cannot occur later than 25 years. A straight or faintly marked irregular outline with an incompletely developed lower extremity, little or no grey streak and a fine or average textured bone defines the age as between 25 and 39 years. A well developed lower extremity with a straight or irregular outline of the ventral face, a fairly dense grey streak and an average textured body suggests 40-55 years. A dense grey streak of outline broken into patches with an angular lower extremity and an open textured body indicates an age of 55 years or more. The work of Todd was later developed and refined by Mckern and Stewart (1957) but their methods were almost totally anatomical and had no radiological content.<sup>19</sup>

Todd's study made several important contributions to later methods. His conclusions include that "the symphyseal face undergoes a distinct metamorphosis after puberty" and that these changes have a "definite but not an invariable age

relationship (Todd, '21c: 36)." He also noted that individual variation, disease, and way of life may affect the age relationship. Finally, he noted that the metamorphosis, after the age of 18 years, is comprised of remodeling rather than new bone deposition.<sup>20</sup>

A study was done in Japan (1952) on a series of 135 male Japanese pubic bones ranging in ages from 17-50 years by applying Todd's pubic phases. As per this study, the age changes stated by Todd are also applicable to the Japanese individuals. But however, they do not coincide with that of the Todd, in the divisions of each age period. Hence, it concluded that the age changes in pubic bone of Japanese individuals were 2-3 years earlier.<sup>21</sup>

A study was done in US (1955) that checked Todd's pubic phase schedules on 470 aboriginal American Indians. This study founded that, estimates in males had a high correlation with known age whereas females were a bit lower. This study modified Todd's age limits for the pubic symphysis by shifting phases V-VIII about three years downwards (younger). So like Hanihara (Japan, 1952) it found Todd's phases tending to over age specimens for females.<sup>22</sup> The phases as described are as follows-

<b>Phase</b>	<b>Age Range in years</b>	<b>Description</b>
<b>I</b>	<b>18-19 -</b>	Symphyseal surface rugged, traversed by horizontal ridges separated by well marked grooves; no ossific nodules fusing with the surface; no definite delimiting margin; no definition of extremities.
<b>II</b>	<b>20-21 -</b>	Symphyseal surface still rugged, traversed by horizontal ridges, the grooves between which are, however, becoming filled near

the dorsal limit with a new formation of finely textured bone. This formation begins to obscure the hinder extremities of the horizontal ridges. Ossific nodules fusing with the upper symphyseal face may occur; dorsal limiting margin begins to develop, no delimitation of extremities; foreshadowing of ventral bevel.

- III**    **22-24** -    Symphyseal face shows progressive obliteration of ridge and furrow system: commencing formation of the dorsal plateau; presence of fusing ossific nodules; dorsal margin gradually becoming more defined; beveling as a result of ventral rarefaction becoming rapidly more pronounced; no delimitation of extremities.
- IV**    **24-26** -    Great increase of ventral beveled area; corresponding diminution of ridge and furrow formation; complete definition of dorsal margin through formation of the dorsal plateau: commencing delimitation of lower extremity.
- V**    **26-27** -    Little or no change in symphyseal face and dorsal plateau except that sporadic and premature attempts at the formation of a ventral rampart occur; lower extremity, like the dorsal margin, is increasing in clearness of definition; commencing formation of upper extremity with or without the intervention of a bony (ossific) nodule.
- VI**    **27-34** -    Increasing definition of extremities; development and practical completion of ventral rampart; retention of granular appearance of symphyseal face and ventral aspect of pubis; absence of

- lipping of symphyseal margin.
- VII**    **34-38** -    Changes in symphyseal face and ventral aspect of pubis consequent upon diminishing activity; commencing bony outgrowth into attachments of tendons and ligaments, especially the gracilis tendon and sacro-tuberous ligament.
- VIII**    **38-42** -    Symphyseal face generally smooth and inactive; ventral surface of pubis also inactive; oval outline complete clearly defined; no distinct 'rim' to symphyseal face; no marked lipping of either dorsal or ventral margin.
- IX**    **42-51** -    Symphyseal face presents a more or less marked rim; dorsal margin uniformly lipped; ventral margin irregularly lipped.
- X**    **>51** -    Symphyseal face eroded and showing erratic ossification; ventral border more or less broken down; disfigurement increases with age.<sup>23</sup>

Another research done in US (Mckern and Stewart 1957) made further very useful revisions as remedial to the many problems faced by Todd.<sup>24</sup> In this study, a method was developed on remains of American soldiers (750 skeletons) received from North Korea and was therefore, exclusively male. Hence, it rejected Todd's archetypal system, writing that Todd may have been essentially right in his selection of cases to typify successive periods, but the result was a static method of age determination. Since the variability of each feature was lost, only those pubic bones which are close to the typical can be aged with reasonably accuracy. They started with Todd's nine morphological features as mentioned previously. It was noted that feature 1, (Ridges and furrows) was divided by a longitudinal ridge or groove into dorsal and ventral halves, these were accordingly termed dorsal demi-face and ventral

demi-face. Obliteration of ridges and grooves was not considered a separate feature.

It was then observed that features

4 (Lower extremity) and 2 (Dorsal margin)

6 (Upper extremity) and 3 (Ventral beveling)

5 (Superior ossific nodule) and 7 (Ventral rampart)

were inter-related and that all six features might well be included in the description of two demi-faces. Similarly features 2 (Dorsal margin) and 8 (Dorsal plateau), 3 (Ventral beveling) and 4 (Lower extremity) were considered to be inter-related and part of the demi-face complex. This recombining leaves features 9 (Symphyseal rim) as distinct. Thus the 9 features of Todd are reduced to three basic components each with five developmental stages 9 (1-5). A preliminary stage 'O' denotes absence of features in question precedes each set of stages. Description of developmental stages for each of the component is as follows:

### **Component I - Dorsal Plateau**

In the early age groups (up to 17-18 years), the symphyseal surface is covered by a pattern of transverse ridges and grooves. With progressing age, a delimiting dorsal margin appears that eventually outlines the entire dorsal half of the surface. Then, through the interacting processes of resorption and fill-in, the ridge groove pattern becomes obliterated, to give the resulting surface a flat, platform – like aspect.

### **Age limits and Description of Component I**

<b>Stage</b>	<b>Age Range</b>	<b>Description</b>
	<b>in years</b>	
O	17-18 -	Dorsal margin absent.
I	18-21 -	A slight margin formation first appears in the middle third of the border

II	18-21 -	The dorsal margin extends along entire dorsal border.
III	18-24 -	Filling-in of grooves and resorption of ridges to form a beginning plateau in the middle third of the dorsal demi-face
IV	19-29 -	The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
V	23+ -	Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.

### **Component II – Ventral Rampart (ventral demiface)**

Early in the development of component II, the ventral half of the symphyseal face has a porous appearance and is beveled. Over this beveled surface an epiphysis, or rampart, forms as an in-growth from its upper and lower extremities. This pattern is variable, however, and the rampart may remain incomplete. Such cases are characterized in the older age groups by a depression in the middle two – thirds of the ventral border.

#### **Age limits and Description of Component II**

<b>Stage</b>	<b>Age Range in years</b>	<b>Description</b>
O	17-22 -	Ventral beveling is absent.
I	19-23 -	Ventral beveling is present only at superior extremity of ventral border.
II	19-24 -	Bevel extends inferiorly along ventral border.
III	21-28 -	The ventral rampart begins by means of bony extension from either or both of the extremities.
IV	22-33 -	The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
V	24+ -	The rampart is complete.

### Component III – Symphyseal Rim

After Component I and Component II have nearly completed their development and the symphyseal articular face is more or less level in character, there next is formed a distinct and elevated rim which ultimately surrounds the entire face. At the same time, the bony texture of the face undergoes a transformation from granular to finely grained and smooth. Following the completion of the symphyseal rim, there is a period during which changes are minute and infrequent. Ultimately, the rim is worn down, and the resulting smooth surface extends to the margins of the face. In addition, as the face levels off it undergoes erosion and erratic ossification, and lipping may occur along the margins.

#### Age limits and Description of Component III

Stage	Age Range in years	Description
O	17-24 -	The symphyseal rim is absent.
I	21-28 -	A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.
II	24-32 -	The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.
III	24-39 -	The symphyseal rim is complete. The irregular or undulating in appearance
IV	29+ -	The rim begins to break down. The face enclosed symphyseal surface is finely grained in texture and becomes smooth and flat and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge.

V 38+ - Further breakdown of the rim (especially along superior ventral edge) and rarefaction of the symphyseal face. There is also disintegration and erratic ossification along the ventral rim.

A steady, uniform age progression is obvious for all three components. With three variables taken 5 times the number of possible combinations is  $5^3 = 125$ .

Actually, however, it founded only 21 different formulae, as follows:<sup>25</sup>

000 300 420 442 552 100 310 430 541 553  
 200 320 431 542 554 210 410 441 543 555

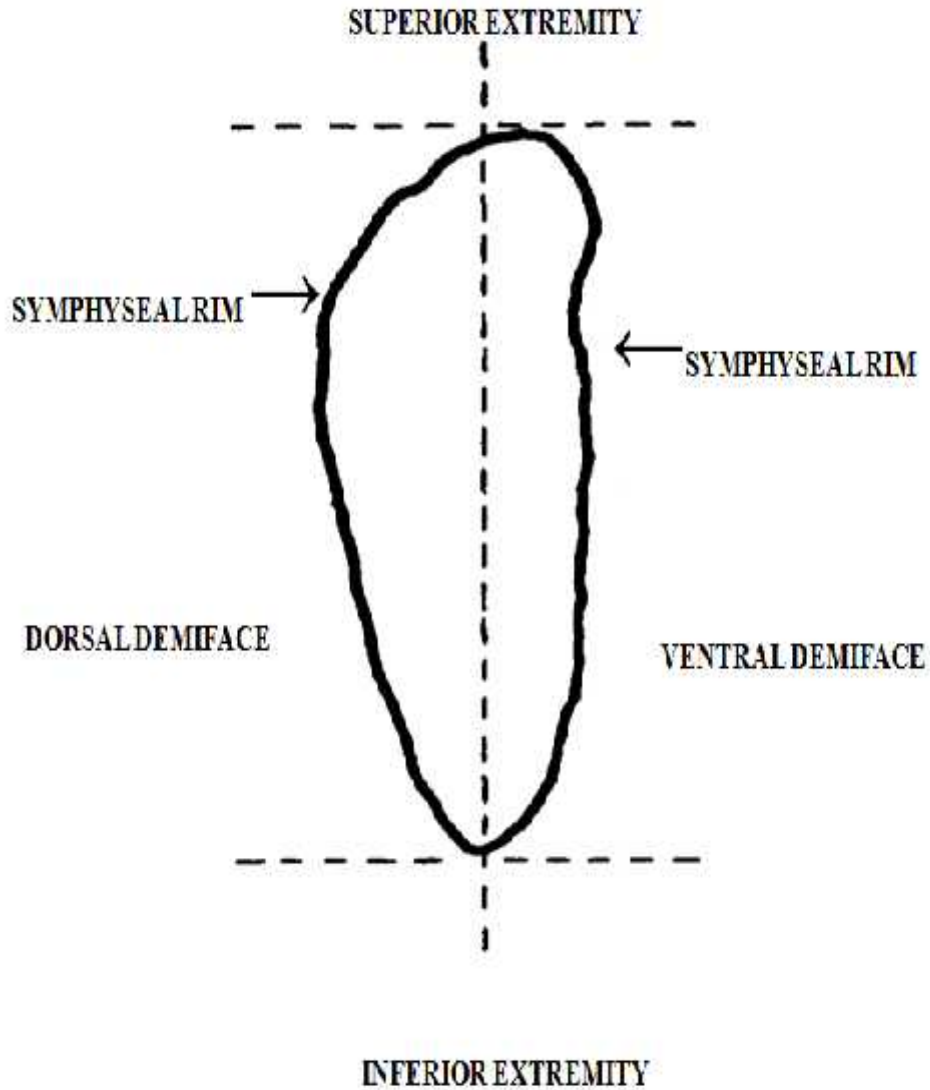
<b>Table No:-1</b>				
<b>Calculated Mean Age, Standard Deviation And Age Ranges For The Total Scores Of Symphyseal Formula</b>				
<b>Total score</b>	<b>No of cases</b>	<b>Age range</b>	<b>Mean</b>	<b>S.D</b>
0	7	-17	17.29	.49
1-2	76	17-20	19.04	.79
3	43	18-21	19.79	.85
4-5	51	18-23	20.84	1.13
6-7	26	20-24	22.42	.99
8-9	36	22-28	24.14	1.93
10	19	23-28	26.05	1.87
11-13	56	28-39	29.18	3.33
14	31	29+	35.84	3.89
15	4	36+	41.00	6.22

Total = 349

It should be noted that this was the first system for which casts of symphysis were issued for comparison purposes. The set contained fifteen casts, which represented each of the five stages for each of the three components (Mckern and Stewart, '57). This is somewhat ironic as it was something of a variation of the archetypal system they criticized.

The plastic models may be used in estimating the skeletal age of American males 17 to 40 years of age. The component and stage numbers for all models are stamped on the base of the model. Instructions for using the models are given below:

- (1) View each model with the superior and inferior extremities in the vertical axis. Elements of the symphyseal components of the pubic bone are shown in figure number 2. All models represent left symphyses except 1, 2, 4, and 5 of component II.
- (2) Place the symphyseal face of the pubic bone for age determination in similar relation to the plastic models.
- (3) Compare the dorsal demiface (component 1) and select the model stage that is most like the unknown demiface. If symphyseal change has not begun, score the component as 0. When the appropriate stage has been selected, score the component by reading the stage number (1 through 5) from the base of the model. Component I is for the dorsal demiface only.



**FIG No. 2 SHOWING THE ELEMENTS OF THE SYMPHYSEAL COMPONENTS OF PUBIC BONE**

- (4) Follow the same procedures as above for the ventral demiface (component II).
- (5) Compare the symphyseal rim and in closed surface (component III) of the unknown symphysis with the model component stages. If the rim has not begun to form, score the component as 0. Match and select the appropriate stage and score as before. These three scores are then added and the predicted age from that sum can be read from<sup>26</sup> Table Number 2

Table No: - 2

Age limits of the component stages in the male pubic symphysis

Stage	Age Range in years	Mode
<b>Component – I</b>		
<b>0</b>	17.0 – 18.0	17.0
<b>I</b>	18.0 – 21.0	18.0
<b>II</b>	18.0 – 21.0	19.0
<b>III</b>	18.0 – 24.0	20.0
<b>IV</b>	19.0 – 29.0	23.0
<b>V</b>	23.0 +	31.0
<b>Component - II</b>		
<b>0</b>	17.0 – 22.0	19.0
<b>I</b>	19.0 – 23.0	20.0
<b>II</b>	19.0 – 24.0	22.0
<b>III</b>	21.0 – 28.0	23.0
<b>IV</b>	22.0 – 33.0	26.0
<b>V</b>	24.0 +	32.0
<b>Component - III</b>		
<b>0</b>	17.0 – 24.0	19.0
<b>I</b>	21.0 – 28.0	23.0
<b>II</b>	24.0 – 32.0	27.0
<b>III</b>	24.0 – 39.0	28.0
<b>IV</b>	29.0 +	35.0
<b>V</b>	38.0 +	-

Todd (1923) had the impression that there is no sex difference in age changes of the pubic symphysis or in the rates of these changes. According to him “unless it is absolutely unavoidable, the symphysis should never be used alone. Age prediction is at best an approximation; the most sanguine would not expect the prediction to be within less than two or three years if founded upon the entire skeleton, or to within less than five years if founded upon the pelvis alone.”<sup>27</sup> However, Stewart (1957) felt that child bearing may be a factor in causing certain symphyseal changes like pitting and deformation of the dorsal border in some females as a result of trauma during child bearing period. So during assessment of age the result may be mistaken for old age. Hence, concluded that “assessment of age of females by the pubic symphysis cannot be as accurate as in the case of males. So it was necessary to be more cautious in applying male pubic standards to female.”<sup>28</sup>

Thus with the basic work of Todd and the refinements introduced by Brooks, McKern and Stewart, the pubic symphysis takes its place as the most reliable indicator of age in the human skeleton.

An important research was done (Mckern and Gilbert 1973) on 103 female pubic symphysis of known parity and age and developed a new method for ageing female pubic symphysis. Male pubic standards of Mckern and Stewart (1957) was not applicable for female pubic symphysis as they found that there were significant differences in male and female patterns and developed a system to respond to them. A very important difference is in the symphyseal rim. "In males the symphyseal rim encloses both dorsal and ventral demi-faces; in females it separates the two." Ignoring this factor would cause the user of the Mckern-Stewart method to define the ventral rampart differently and, thus, decrease their accuracy. They demonstrated that females are absolutely different from males, in the rate and locality of age related

metamorphic changes in the pubis. They also like McKern and Stewart (1957) found it best to reduce the number of features considered by Todd to three basic components and follow these through a succession of metamorphic changes. These three components are as follows:

### **Component - I (Dorsal demi-face)**

From birth to about 16 years of age, the dorsal demi-face is made up of ridges and furrows of very fine grained bone. About the age of 16, the mid third of the dorsal demi-face begins to flatten as the area of contact of the two symphyses increases. A dorsal margin extends superiorly and inferiorly from the mid-third and the ridges and furrows continue to flatten and fill in as the dorsal demi-face spreads ventrally. The last stage of development by the dorsal demi-face is characterized by the completion of the dorsal margin and the extension of the flattened area along the ventral edge of the dorsal demi-face.

#### **Description of Component I**

<b>Stage</b>	<b>Description</b>
<b>0</b>	Ridges and furrows very distinct, ridges are billowed, dorsal margin, not defined.
<b>I</b>	Ridges begin to flatten, furrows to fill in and a flat dorsal margin begins in mid-third of demi-face.
<b>II</b>	Dorsal demi-face extends ventrally and becomes wider as flattening proceeds; dorsal margin extends superiorly and inferiorly.
<b>III</b>	Dorsal demi-face is quite smooth; margin may be narrow or not distinct from the face.
<b>IV</b>	Demi-face is complete and unbroken; it is broad and very fine grained, but may exhibit vestigial billowing.
<b>V</b>	Demi-face becomes pitted and irregular because of rarefaction.

### Component – II (The Ventral Rampart)

The ventral rampart (demi-face) is beveled and slope away from contact with its opposite, unlike the dorsal demi-faces which oppose each other. The ventral rampart undergoes flattening and fills in at a protracted rate. This fills in and flattening of ridges and furrows begins first along the inferior end and proceeds superiorly; next it begins at the superior end and proceeds inferiorly. Finally the ventral rampart is complete; its lateral border is a curved line from the pubic crest to the inferior ramus. The rampart may be flat and solid or irregular and pitted.

### Description of Component II

Stage	Description
<b>0</b>	Ridges and furrows very distinct. The entire demi-face is beveled up towards the dorsal demi-face. Dorsal margin begins in mid-third of demi-face.
<b>I</b>	The furrows of the ventral demi-face begin to fill in inferiorly, forming and expanding beveled rampart, the lateral margin of which is a distinct, curved line extending the length of the symphysis.
<b>II</b>	Fill in of the furrows and expansion of demi-face continues from both superior and inferior ends, rampart spreads laterally along its ventral edge.
<b>III</b>	All except one third of the ventral demi-face is filled in with fine grained bone.
<b>IV</b>	The ventral rampart has a broad, complete, fine grained surface from the pubic crest to the inferior ramus.
<b>V</b>	Ventral rampart may begin to breakdown, assuming a much pitted and perhaps cancellous appearance.

### Component – III (The Symphyseal Rim)

Dorsally, the rim is evident from about age 22 years, but it is only after the complete development of the dorsal demi-face that the rim becomes apparent ventrally. It is then a line of separation between the dorsal demi-face and ventral rampart. The ventral aspect of the symphyseal rim develops slowly and is not usually complete and unbroken until the end of the third decade; then, about the middle of the fifth decade, this portion of the rim may begin to break down or simply disappear through grinding so that there may no longer be a clear dividing line between the dorsal demi-face and the ventral rampart.

### Description of Component III

Stage	Description
<b>0</b>	The rim is absent.
<b>I</b>	The rim begins in the mid-third of the dorsal surface.
<b>II</b>	The dorsal part of the symphyseal rim is complete.
<b>III</b>	The rim extends from the superior and inferior ends of the symphysis until all except one – third of the ventral aspect is complete.
<b>IV</b>	The symphyseal rim is complete.
<b>V</b>	Ventral margin of dorsal demi-face may break down so that gaps appear in the rim, or it may round off so that there is no longer a clear dividing line between the dorsal demi-face and the ventral rampart.

**Table No.3**  
**Age limits of the component stages in the female pubic symphysis**  
**(Gilbert and Mckern study)**

<b>Stage</b>	<b>Age Range in years</b>	<b>Mode</b>
<b>Component – I</b>		
<b>0</b>	14-24	18.0
<b>I</b>	13-25	20.0
<b>II</b>	18-40	29.8
<b>III</b>	22-40	31.0
<b>IV</b>	28-59	40.8
<b>V</b>	33-59	48.0
<b>Component - II</b>		
<b>0</b>	13-22	18.6
<b>I</b>	16-40	22.5
<b>II</b>	18-40	29.6
<b>III</b>	27-57	38.8
<b>IV</b>	21-58	40.9
<b>V</b>	36-59	48.5
<b>Component - III</b>		
<b>0</b>	13-25	20.2
<b>I</b>	18-34	21.8
<b>II</b>	22-40	32.0
<b>III</b>	22-57	35.1
<b>IV</b>	21-58	39.9
<b>V</b>	36-59	49.4

The degree of traumatic change observed in the combined sample indicated that only rarely pubis is rendered impossible for age determination.<sup>29</sup>

In India the earliest research was done (1975) in Osmania Medical College, Hyderabad. It examined 126 pubic bones and concluded that, in males' age estimation by Mckern and Stewart method is more accurate in the younger age group (16-35 years). It gave indication of age within the range of 5-6 years and after that the changes in pubic bone show a long variation in age estimation. In females age estimation was more accurate in higher age group (32-50 years) than younger age group. In the younger age group (16-32 years), either birth trauma on the dorsal demi-face of symphysis pubis or different rates of maturation and its locality may result in over ageing or under ageing of pubic bones respectively by this method. Age can be estimated from pubic bones in females in the range of 5-8 years after 32 years. Parturition (Child birth trauma) probably may produce or bring changes in female pubic bones which may be over aged by this method.<sup>30</sup>

Table No: - 4

Findings in Research done in Hyderabad (1975)

Stage	No of cases	Age range in years	Mean
<b>Component I</b>			
<b>0</b>	2	-16	16.00
<b>I</b>	3	17-18	17.33
<b>II</b>	6	18-22	19.66
<b>III</b>	11	19-22	20.54
<b>IV</b>	5	20-24	23.00
<b>V</b>	70	25+	36.31
<b>Component II</b>			
<b>0</b>	13	16-20	18.69
<b>I</b>	9	19-22	20.33
<b>II</b>	2	22-24	23.00
<b>III</b>	4	22-25	24.00
<b>IV</b>	6	25-30	26.22
<b>V</b>	63	25+	38.22
<b>Component III</b>			
<b>0</b>	24	16-23	20.46
<b>I</b>	8	24-25	24.62
<b>II</b>	15	25-30	27.06
<b>III</b>	13	25-35	30.00
<b>IV</b>	26	35-53	39.26
<b>V</b>	21	45+	54.54

Another study was done in Japan (1978), it assessed the age from pubic symphyseal surface employing a multiple regression analysis to seven variables. Its variables are scores of 1 or 2, 1, 2, or 3, and 1, 2, 3, or 4 for seven features: horizontal ridges and furrows, pubic tubercle, lower end, dorsal margin, superior ossific nodule, ventral beveling, and symphyseal rim. As per this study, its method was however limited to samples between 18-38 years because age changes in the symphyseal surface showed large variations after about 40 years. The reliability of this method was also examined.<sup>31</sup>

The Gilbert-Mckern method for aging the female pubic symphysis was tested (1979). This study required 23 professional forensic anthropologists to age 11 pubic bones using the method. Responses varied widely among the anthropologists and only 51% of the responses proved accurate. Hence, it concluded that the variation and inaccuracy in the responses stemmed from difficulties in understanding and applying the complex method.<sup>32</sup>

An age changes in pubic symphysis study was conducted in Bihar (1981) on 83 male and 32 female pubic bones. It studied for age changes following Todd (1). Variations such as fine ridges on dorsal and ventral margins, lipping of dorsal margin, erosion of symphyseal surface were taken into consideration. Anomalies like 'speeding up', 'retardation', 'mixed phases', curved and S shaped symphyseal surface and asymmetry were noted.<sup>33</sup>

A study was conducted in South Kerala (1981) on 104 males and 46 female pubic bones of the age group 14-80 years. As per this research, a table showing mean age and standard deviation for the total score was prepared separately for male and female. By using this table the total score was translated into age (indirect method). A functional relationship between the age and total score was founded separately for

males and females. By using this method, age was determined (direct method). In 82% of males, age was correctly predicted with an average error of 2-10 years. It revealed that, direct method seems to be less reliable than indirect method both for males and females. But in females indirect method yielded a prediction of 90.24% with an average error of  $\pm 2.25$  years. There was no consistent tendency to over age or under age. As per this research, the reliability of age determination from pubic symphysis is more in males compared to females.<sup>34</sup>

A Preliminary study of age changes on Gujarati (Indian) pubic bones was done (1983). It studied 60 male and 60 female pubic bones in the age group 14-60 years. It founded that, the accepted data give inaccurate values, some over ageing the specimen and some reverse.<sup>35</sup>

An anthropological analysis was done (1983), which made a modification for the Mckern and Stewart method for males and Gilbert and Mckern method for females. Examination of data for both sexes revealed that the relationship of the total symphyseal score with predicted age and observed standard deviation can be expressed by a set of simple linear and polynomial equations. It was statistically more efficient since it used the total data base rather than independently treated data subsets in predicting age from total symphyseal score. It had the added advantage of providing a simple method of predicting symphyseal age on small computers or programmable calculators. As per this anthropological analysis, it plotted the age means against symphyseal score. The figure showed strong curvilinear relationship between symphyseal score and age in both sexes. The equations are

$$\begin{aligned} \text{Male: Age (years)} &= 17.1648 + 1.4167 x - 0.1822 x^2 \\ &+ 0.0126 x^3 \end{aligned}$$

$$\begin{aligned} \text{Females: Age (years)} &= 14.7428 + 4.2506 x \\ &\quad - 0.4784 x^2 + 0.259 x^3 \end{aligned}$$

In which x is the symphyseal score

$$\begin{aligned} \text{Male S.D. (years)} &= 0.6591 + 0.0705 x - 0.0023 x^2 \\ &\quad + 0.0011 x^3 \end{aligned}$$

$$\text{Female S.D (years)} = 2.29 + 0.27 x$$

The equations presented here do not significantly reduce the accuracy of age estimation derived from symphyseal score. In theory at least it should enhance the predictive power since the equations are derived from the data as a whole whereas in the original studies the age categories were treated independently.<sup>36</sup>

Another research was done in Osmania Medical College, Hyderabad (1985). Estimation of age from pubic symphysis, this research examined 115 pubic bones in the age group of 16 -70 years (77 male, 38 female) and applied McKern and Stewart method to both male and female bones. It concluded that, in males age estimation by McKern and Stewart method was accurate in the younger age group (17-35 years) and in females age estimation by McKern and Stewart method was not accurate. In females, age was estimated with an error of 3 to 5 years up to 30 years of age, which was less than 2-3 years of actual age. From 4<sup>th</sup> decade onwards, the error was more than 5 years with an under ageing of 5-10 years of actual age.<sup>37</sup>

Table No: - 5

Findings of the Research (1985)

Stage	No of cases	Age range in years	Mean
<b>Component I</b>			
<b>0</b>	2	-16	16.00
<b>I</b>	3	17-18	17.33
<b>II</b>	2	19-20	19.50
<b>III</b>	3	19-24	21.50
<b>IV</b>	5	22-24	23.20
<b>V</b>	63	25+	37.44
<b>Component II</b>			
<b>0</b>	6	16-20	17.33
<b>I</b>	3	19-22	20.00
<b>II</b>	1	24	24.00
<b>III</b>	7	22-26	24.00
<b>IV</b>	13	23-35	26.92
<b>V</b>	47	25+	47.70
<b>Component III</b>			
<b>0</b>	10	16-22	18.60
<b>I</b>	10	23-26	24.70
<b>II</b>	12	23-35	26.52
<b>III</b>	14	25-40	34.29
<b>IV</b>	24	35-56	42.58
<b>V</b>	7	40+	57.85

The blind assessment of a skeletal sample with documented ages (Todd collection) was done (1985). Its results showed that, all systems tended to under age and presented a revised standard for age determination.<sup>38</sup>

The most recent and popular method today was introduced (1986). It evaluated both the Todd (1920) and Mckern and Stewart (1957) methods utilizing a large sample of pubic bones from 739 males assembled by the County of Los Angeles Medical Examiner-Coroner's office.<sup>39</sup> The researchers reported problems with both methods. Namely, the Todd system tended to overage individuals and was developed on a sample highly skewed toward older individuals. Furthermore, they argued that the Western Reserve (Hamman-Todd) collection comes from an indigent population with highly questionable age documentation. Therefore, actual age for these individuals may not be certain, making the population unsuitable for development and testing of an age evaluation method.<sup>40</sup> The sample utilized by Mckern and Stewart (1957) originated from military males of the Korean War; so age documentation of this sample was found to be acceptable by the researchers. However, contrary to the concerns with the Todd sample, the Mckern and Stewart sample was highly skewed toward young males in their twenties. Furthermore, this study noted that the three-component system suggested by Mckern and Stewart was more difficult to utilize and that both systems were ill equipped to deal with age variability in advanced pubic bone patterns. Instead of these systems, the researchers suggested a modified Todd system that reduces the ten original Todd phases into six model phases were as follows.

## REVIEW OF LITERATURE

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<b>Phase</b>	<b>Age range in years</b>	<b>Description</b>
<b>I</b>	<b>15-23 -</b>	Symphyseal face has a billowing surface which extends to include the pubic tubercle. The horizontal ridges may be either well-marked or in the process of obliteration. Dorsal plateau may be in beginning phases of formation; ventral border is not yet forming. A key to the recognition of this phase is the lack of delimitation of the extremities. Ossific nodules may occur.
<b>II</b>	<b>19-35 -</b>	Symphyseal face shows commencing delimitation of lower and/or upper extremities. Some bones still show ridge development. Dorsal margin is completed. Ventral border, upper and lower extremities, may be in progress of delimitation through the presence of developing ossific nodules.
<b>III</b>	<b>22-43 -</b>	Symphyseal face shows lower extremity and ventral rampart in the process of completion. There is a continuation of fusing ossific nodules forming the upper extremity and ventral border. Symphyseal face is smooth or can continue to show distinct ridges. Absence of lipping of symphyseal margin, no bony ligamentous outgrowths.
<b>IV</b>	<b>23-59 -</b>	Symphyseal face is generally finely grained although remnants of the old ridge and furrow system may still remain. Usually the oval outline is complete at this stage, but occasionally a hiatus can occur in ventral rim. Pubic tubercle is fully separated from the symphyseal face by definition of

the upper extremity. The symphyseal face may have a distinct rim. Commencing bony outgrowths on inferior half of the symphysis pubis may occur. However, there is no marked lipping of symphyseal margin.

- V**      **28-78** - Symphyseal face is completely rimmed with some slight depression of the face itself, relative to the rim. More pronounced "rimming" occurs on the dorsal margin, with moderate lipping on the ventral margin.
- VI**      **36-87** - Symphyseal face shows ongoing depression as rim erodes. Ventral ligamentous attachments are marked. In many individuals the pubic tubercle appears as a separate bony knob. The face may be pitted or porous, giving an appearance of disfigurement with the ongoing process of erratic ossification.<sup>41</sup>

A separate set of phase models were provided (1988) and descriptions for female specimens developed from a sample of 273 pubic bones taken at autopsy from people of known age. It followed the same methodology utilized in the previous male study. The researchers reported that the female sample differed importantly from the male sample in morphology, as well as age progression. While both sexes showed parallel changes that can be sectioned into a six-phase system, female sample demonstrated advanced ages for each phase compared to the males. Therefore, a separate set of models and corresponding age ranges was suggested for female specimens were as follows-

## REVIEW OF LITERATURE

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<b>Phase</b>	<b>Age range in years</b>	<b>Description</b>
<b>I</b>	<b>15-24 -</b>	Symphyseal face has a billowing surface (ridges and furrows) which usually extends to include the pubic tubercle. The horizontal ridges are either well-marked or in the process of obliteration. Dorsal margin may be in beginning phases of formation; ventral beveling may be commencing. Although ossific nodules may occur on the upper extremity, a key to the recognition of this phase is the lack of delimitation of either extremity (upper or lower).
<b>II</b>	<b>19-40 -</b>	The symphyseal face may still show ridge development. The face has commencing delimitation of lower and/or upper extremities with or without ossific nodules. The ventral rampart may be in beginning phases as an extension of the bony activity at either or both extremities.
<b>III</b>	<b>21-53 -</b>	Symphyseal face shows lower extremity and ventral rampart in process of completion. There can be a continuation of fusing ossific nodules forming the upper extremity and along the ventral border. Symphyseal face is smooth or can continue to show distinct ridges. Dorsal plateau is complete. Absence of lipping of symphyseal dorsal margin; no bony ligamentous outgrowths.
<b>IV</b>	<b>26-70 -</b>	Symphyseal face is generally finely grained although remnants of the old ridge and furrow system may still remain. Usually the oval outline is complete at this stage, but occasionally a

hiatus can occur in ventral rim. Pubic tubercle is fully separated from the symphyseal face by definition of the upper extremity. The symphyseal face may have a distinct rim. Ventrally, bony ligamentous outgrowths may occur on the inferior portion of the pubic bone adjacent to the symphyseal face. If any lipping occurs it will be slight and located on the dorsal border.

- V 25-83 -** Symphyseal face is completely rimmed with some slight depression of the face itself, relative to the rim. Moderate lipping is usually found on the dorsal border with more prominent ligamentous outgrowths on the ventral border. There is little or no rim erosion. Breakdown may occur on superior ventral border.
- VI 42-87 -** Symphyseal face may show ongoing depression as rim erodes. Ventral ligamentous attachments are marked. In many individuals the pubic tubercle appears as a separate bony knob. The face may be pitted or porous, giving an appearance of disfigurement with the ongoing process of erratic ossification. Crenulations may occur. The shape of the face is often irregular at this time.<sup>42</sup>

A Chinese study was done (1989), to estimate pubic age among Chinese Han people by means of multiple stepwise progressive analyses. As per this study, it has set up an equation for estimating male and female ages separately by means of a computer with mathematical model of multiple progressions on data of 454 pairs of

pubis. Its equation upgrades a standardization of pubic age estimation to quantification.<sup>43</sup>

The determination of age by morphological signs of pubic symphysis study was done (1990). In this 195 female and 170 male pubis were analyzed, it developed regression equations to determine individual age on the basis of the results of age dynamics study in relation to 5 morphological characteristics of pubic joint. (Joint surface, front and rear borders, upper and lower ends). According to this method, it makes possible to determine individual age within the interval of 15-90 years (Mean error 7-23 years, co-relation factor 0.9261).<sup>44</sup>

Another research was done in Kerala (1993), which collected 44 pubic symphysis in the age group of 17-60 years (33 were male and 21 were female) and examined. It applied Todd method and Mckern and Stewart method for males and for females. As per this research, it revealed that Todd (1920) method was direct and simple with reasonable degree of accuracy for both males and females. Mckern and Stewart (1957) method was only reliable in the age range of 17 to 40 years and concluded that there was no special advantage over the Todd (1920) method.<sup>45</sup>

In New Delhi a study on estimation of age from pubic symphysis was done (1995). It was conducted on 82 pairs of pubic symphysis ranging from 12-75 years with the highest concentration in the twenties (38%). This study reveals that the symphyseal surface remained convex up to 19 years and becomes flat after 27 years. The ridges and furrows were distinct till 17 years of age in males. The furrows became shallow between 18 to 26 years and disappear after 27 years. The dorsal margin appeared by 12 years in males and is complete after 18 years of age. The dorsal plateau started forming from 18 years in males and is complete after 35 years of age. The ventral bevelling started forming after 20 years in males. The ventral

rampart appeared after 20 years in males and was well-developed after 35 years of age. The inferior extremity showed its definition after 18 years in males and was well-defined after 30 years of age. The superior extremity started its definition after 22 years in males and was well-defined after 35 years. The symphyseal rim started its formation by 12 years in males from the lower part of the dorsal border. It started on the ventral half after 20 years in males and was completed by 39 years. The rim started to break down after 30 years, with 65.5% of males over 39 years showing this feature. The ossific nodules were observed from 18 to 50 years in males. Lipping on dorsal margin was observed above 30 years in males. Out of which 72.7% cases were above the age of 45 years showed this feature. The disfigurement appeared in 3.5% of males above the age of 40 years. Variations on the two sides, right and left were noted in 34.1% of males. As per this study it reveals that the variations observed in the progression of metamorphic features could be attributed to environmental and dietetic factors.<sup>46</sup>

A study was conducted (2000-2002) at Govt Medical College, Amritsar, Punjab, on determination of age from pubic symphysis in which 336 pubic bones were collected. Out of that, 76.46% were males and 20.54% were females. All the cases were over the age of 17 years. Although 59.23% were from rural and 40.77% were from urban areas, on the result of scoring there was no effect of rural/urban. There was no difference in scoring of right or left pubic bones. Age estimation from different components in males and females up to the total score of 10 (23-28years) was  $\pm 6$ , were as above the score of 10 the estimated age was  $\pm 12$  in males and  $\pm 9$  in females. The age range given for scores 14 and 15 were 29+ and 36+ years respectively was not accounted for variability of age after 40 years. Hence, it concluded that the age assessment from pubic bones in the age group of the fourth

decade and beyond is not reliable. It revealed a comparison of mean age for the total score between American male and Indian male pubic bones showed that metamorphic changes were premature in Americans as compared with Indians. It also compared the mean age for the total score between Indian male and female cases, some females were found to be over age in relation to the metamorphic changes in the pubic bones.<sup>47</sup>

In 2004, a comparative study of age estimation with special reference to dental data and pubic symphysis in autopsy cases was done at Government Medical College and New civil hospital, Surat. As per this study, it was concluded that age estimation carried out by pubic scores is comparable to other methods of age estimation. After taking both data together, it was possible to narrow down the range between alleged age and estimated age in early part of third decade.<sup>48</sup>

Application of Suchey-Brooks method to three dimensional imaging of the pubic symphysis was done recently (2005). It demonstrated excellent agreement between the results of analysis of bone samples and those of the three dimensional images.<sup>49</sup>

Recently, using quantitative variables statistical analysis from pubic bones study was done on Chinese Han population (2007). For age prediction, it used nine indicators of morphological changes, viz: ridges and furrows on the symphyseal surface, ridge of pubic tubercle, lower extremity, ventral beveling ossific nodules, dorsal margin, ventral rampart, general macroscopic changes of symphyseal surface, and bone density of the symphyseal surface. Samples were drawn from 262 male individuals. The study procedures were as follows: Firstly, it examined the morphological features of pubic symphysis using criteria similar to Hanihara's and Suchey-Brooks method. Secondly, it evaluated each stage with an appropriate score.

Thirdly, it deduced four equations of male age assessment of morphological features by statistical analysis. Its results were compared with Hanihara's and Suchey–Brooks method; the similarities and differences among them were discussed objectively. This method produced consistent results as well as developed the criteria of Hanihara's and Suchey–Brooks method.<sup>50</sup>

Another study on estimation of age by pubic symphyseal metamorphosis in East Delhi was conducted on 112 bones (60 males and 52 females). It has been explored by using Mckern-Stewart criteria. The results showed that the Mckern-Stewart criteria can be equally useful in estimation of age for Indian population also. Based on the Mckern-Stewart's criteria up to the accuracy of + 1 year in the age group of 20-30 years, + 5 years in the age group of 30-40 years and + 8 years in the age group of 40-50 years. The morphological changes of the pubic symphysis was started late in this study (Delhi population) as compared to the Mckern- Stewart's study (American population) as well as in Pal and Tamanker's study on Gujarati population. It revealed that, this difference may be due to the continental or regional variation. In this study, it founded one set of morphological changes in all the 3 components was delayed by 3 years as compared to the study conducted by Sinha (1991) on male Delhi population. It was thought that, the delay of 3 years may be due to changes in factors like climatic, dietetic and life style etc of individual staying in Delhi over a decade. Approximate age of individual can be assessed by just studying the morphological changes in any component of symphysis pubis defined by Mckern-Stewart's criteria but for accurate assessment of ages, changes in all the three components should be taken into consideration. After comparing this study with the other works in the subject, it concluded that there is a significant variation in

morphological change of pubic symphysis. Therefore, for age estimation the latest data available of that region should be used for more accurate estimation of age.<sup>51</sup>

A recent research was done (2009) on a study of age estimation from symphysis pubis in Sri Venkateshwara Medical College, Tirupathi, N T R University. It studied 120 pubic symphyses in the age group 14-86 years out of which 80 were male and 40 were female. In males age was determined by Todd (1920) method and McKern and Stewart (1957) method. In females age was determined by Todd (1920) method, Brooks (1955) method and Gilbert and Mckern (1973) method.

As per Todd's method in this research, in males age range was almost similar to the standard study for all phases, except for phase I and X. In females, the age range was almost similar to the standard study for all phases, except for phase I and VIII.

As per Brooks's method in this research, the age range was almost similar to the standard study for all phases, except for phase I, V and VIII. In this research it was found that there was no great difference in the estimation of age of females by Todd method and Brooks's method.

This research was compared with standard Mckern and Stewart criteria for males, statistically no significant difference was found up to the age of 35 years. Hence, it concluded that age estimation in males by Mckern and Stewart method was accurate up to the age of 35 years only.

It was compared with the standard Gilbert and Mckern study, statistically significant difference was not found up to the age of 60 years. Hence, it concluded that age estimation in females by Gilbert and Mckern method gave good results up to the age of 60 years in females.<sup>52</sup>

A total number of 50 human pubic bones were collected from dead bodies brought for medicolegal autopsies in the mortuary of Department of Forensic Medicine & Toxicology, Jawaharlal Nehru Medical College, Belgaum. Prior approval by the Institutional Ethics Committee for removal of bones was taken.

The dead bodies from which the bones were collected were of known ages between 20-40 years. Out of these, 37 were males and 17 were females. Males outnumbered females as there were more male autopsies than females during the study period, though equal number of cases would have been better.

### **INCLUSION CRITERIA**

- ❖ Age group between 20-40 years.
- ❖ Subjects without a history of any disease or deformity affecting the bones during their lifetime.

### **EXCLUSION CRITERIA**

- ❖ Diseases of bones.
- ❖ Accidents involving pelvis fracture.

The autopsies were personally attended by the investigator to find out from the relatives or friends the details regarding the age, date of birth, previous history regarding any diseases, especially of bones. The details were filled as per the profoma given below [Included separately].

### TECHNIQUE OF COLLECTION OF PUBIC BONES

Permission for collection of samples was taken by the nearest relative before postmortem. A premade consent form [Included separately] was used for the permission.

After the completion of postmortem, bilateral superior ramus of pubic bones 3 cm outside of pubic tubercles was sawed with saw blade through the obturator foramen and then bilateral inferior ramus of the pubic bone from above downwards. After removing the pubic bone, soft tissues attached to the bone were removed without disturbing the pubic symphysis. Each bone was assigned a number. Samples thus collected were buried into the earth for a period of 6-8 weeks to separate the bone from soft tissue of either side by natural process of decomposition. Other methods recommended by some authors for removal of soft tissues of pubic bone such as acid digestion method or removal by scraping with a knife were avoided because of the possible damage to the morphological appearance of the pubic bone.

The bones, after removal from soil, were washed with mild soap water, air dried and studied by using Mckern-Stewart criteria's model casts. As per the Mckern-Stewart criteria pubic symphysis was divided into 3 components having six metamorphic changes in each component and the symphyseal surface into dorsal and ventral halves by longitudinal ridge or groove. These halves are termed dorsal demiface (component-I), and ventral demiface (component-II). Component-III is the symphyseal rim, which encircles the two components and appears after the other components have run their course. The total score for an individual is calculated as the sum of the score of all three components.

The component scores and total score for the bone using Mckern-Stewart Criteria were cross tabulated in relation to the known age of the bodies and compared with other studies in Indian population and western population.

The findings were observed by the guide as well as the researcher on two different occasions after a gap of a month. No significant variations were found between the two observations.

**“A CROSS SECTIONAL STYDY OF AGE RELATED PUBIC SYMPHYSEAL  
CHANGES in 3<sup>RD</sup> 4<sup>TH</sup> DECEDES OF LIFE”**

**PROFORMA**

**I.GENERAL PARTICULARS**

- |                                  |                  |
|----------------------------------|------------------|
| 1. Sl. No: -                     | 6. IP No:-       |
| 2. P.M. No: -                    | 7. DOA:-         |
| 3. Date: -                       | 8. DOD:-         |
| 4. Cr/UDR No:- _____ of _____ PS |                  |
| 5. U/S: -                        | 13. Address:-    |
| 9. Name of deceased:-            |                  |
| 10. Age as per police inquest:-  |                  |
| 11. Date of birth: -             | 14. Religion:-   |
| 12. Sex: -                       | 15. Occupation:- |

**II. OTHER FEATURES**

- |                               |                          |
|-------------------------------|--------------------------|
| 1. Identification marks: - a. | 3. Length:- _____Mts     |
| b.                            | 4. Weight: - _____kgs.   |
| 2. Identified by: -           | a. Escorting constable:- |
|                               | b. Relative:-            |

**III. EXAMINATION OF PUBIC SYMPHYSIS SURFACE**

1. Length:-

2. Width:-

3. Morphological indicators of pubic symphysis for age estimation:-

- A. Ridges & furrows
- B. Dorsal margin
- C. Ventral beveling
- D. Lower extremity
- E. Superior ossific nodule
- F. Upper extremity
- G. Ventral rampart
- H. Dorsal plateau
- I. Symphysial rim

**IV. CAUSE OF DEATH**

Place: -

Signature of candidate

Date:-

**INFORMED WRITTEN CONSENT**

Date:

Time:

I, Mr/Ms..... aged ..... Years  
Father/mother/son/husband, ..... of deceased willingly consent to take  
pubic symphysis bone from my .....,  
Mr/Ms....., required for the  
dissertation work undertaken by Dr. Suresh .J Department of Forensic medicine &  
Toxicology, J N Medical College, Belgaum.

The procedure has been clearly explained to me in vernacular language and I have  
understood the same.

**I have gone through the contents of this form before signing it.**

Signature of the consenting person

Witness: (Name and signature)

1.

2.

Mckern and Stewart (1957) method is followed for age estimation from symphysis pubis bone because:

1. It is based on the maturative progress of three independent and easily recognized components of symphyseal surface.
2. This method can also be used in female with caution.
3. Estimation of age can be better evaluated from statistical analysis by the mathematical scoring.
4. Todd's method overages in some individuals. It is not possible to age if a particular pubis does not coincide with one of the Todd's ten phases.
5. Gilbert and Mckern (1973) method is only useful for female pubic bones.

Since the metamorphosis of component I (Dorsal plateau ) and component II ( Ventral rampart ) is confined to the dorsal and ventral halves of symphyseal face respectively, the term "Demiface" ( Dorsal and Ventral ) has been used when referring to these components (Figure No.1)

For observing the symphyseal surface of pubic bones, I considered the three components mentioned below and their developmental stages (0-5)

1. Component I(Dorsal Demiface)
2. Component I(Ventral Demiface)
3. Component I(Symphyseal Rim)

The stages of components are described as follows:

**1. Component I ( Dorsal Demiface )**

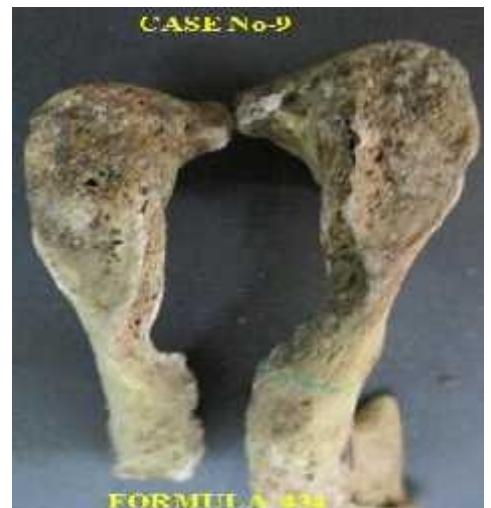
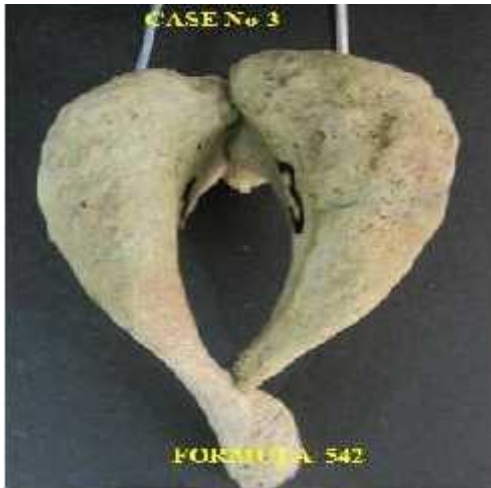
<b>Stage</b>	<b>Description</b>
0 -	Dorsal margin absent.
I -	A slight margin formation first appears in the middle third of the border
II -	The dorsal margin extends long entire dorsal border.
III-	Filling-in of grooves and resorption of ridges to form a beginning plateau in the middle third of the dorsal demi- face
IV -	The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
V -	Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.

**2. Component II (Ventral Demiface)**

<b>Stage</b>	<b>Description</b>
0 -	Ventral beveling is absent.
I -	Ventral beveling is present only at superior extremity of ventral border.
II -	Bevel extends inferiorly along ventral border.
III-	The ventral rampart begins by means of bony extension from either or both of the extremities.
IV -	The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
V -	The rampart is complete.

**3. Component III (Ventral Demiface)**

<b>Stage</b>	<b>Description</b>
0 -	The symphyseal rim is absent.
I -	A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.
II -	The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.
III-	The symphyseal rim is complete. The irregular or undulating in appearance
IV -	The rim begins to break down. The face enclosed symphyseal surface is finely grained in texture and becomes smooth and flat and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge.
V -	Further breakdown of the rim (especially along superior ventral edge) and rarefaction of the symphyseal face. There is also disintegration and erratic ossification along the ventral rim.



Formula indicates the stages of components to which it belongs. E.g. In case No-3 formula is 542 i.e. 5<sup>th</sup> stage of component I, 4<sup>th</sup> stage of component II and 2<sup>nd</sup> stage of component III.

**Case No -3**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 4 The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No -4**

- 3 Filling-in of grooves and resorption of ridges to form a beginning plateau in the middle third of the dorsal demi-face
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 1 A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.

**Case No - 5**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No -6**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No -9**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 4 The rim begins to break down. The face enclosed symphyseal surface is finely grained in texture and becomes smooth and flat and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge

**Case No - 10**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.



Formula indicates the stages of components to which it belongs. E.g. In case No-11 formula is 411 i.e. 4<sup>th</sup> stage of component I, 1<sup>st</sup> stage of component II and 1<sup>st</sup> stage of component III.

**Case No -11**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face
- 1 Ventral beveling is present only at superior extremity of ventral border.
- 1 A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.

**Case No - 14**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No -16**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No -12**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No -15**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face
- 1 Ventral beveling is present only at superior extremity of ventral border.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No - 21**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face
- 1 Ventral beveling is present only at superior extremity of ventral border.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.



Formula indicates the stages of components to which it belongs. E.g. In case No-22 formula is 554 i.e. 5<sup>th</sup> stage of component I, 5<sup>th</sup> stage of component II and 4<sup>th</sup> stage of component III.

**Case No -22**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
  
- 4 The rim begins to break down. The face enclosed symphyseal surface is finely grained in texture and becomes smooth and flat and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge

**Case No -24**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
  
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No -25**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
  
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No -26**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No -28**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
  
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No -29**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
  
- 3 The symphyseal rim is complete. The irregular or undulating in appearance



Formula indicates the stages of components to which it belongs. E.g. In case No-30 formula is 321 i.e. 3<sup>rd</sup> stage of component I, 2<sup>nd</sup> stage of component II and 1<sup>st</sup> stage of component III.

**Case No- 30**

- 3 Filling-in of grooves and resorption of ridges to form a beginning plateau in the middle third of the dorsal demi- face
- 2 Bevel extends inferiorly along ventral border.
- 1 A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.

**Case No- 32**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 4 The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No-34**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
- 2 Bevel extends inferiorly along ventral border.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No- 31**

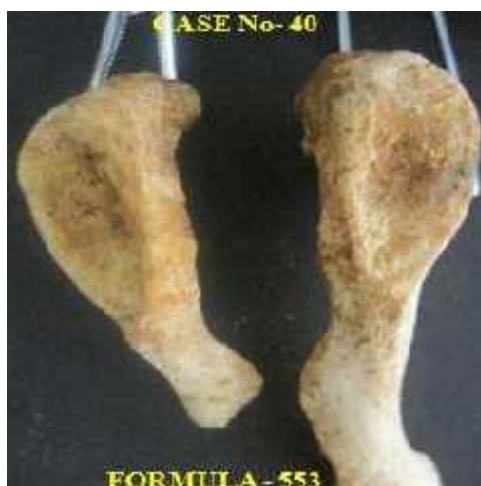
- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
- 1 Ventral beveling is present only at superior extremity of ventral border.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No- 33**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
- 4 The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
- 4 The rim begins to break down. The face enclosed symphyseal surface is finely grained in texture and becomes smooth and flat and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge.

**Case No- 35**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 5 Further breakdown of the rim (especially along superior ventral edge) and rarefaction of the symphyseal face. There is also disintegration and erratic ossification along the ventral rim.



Formula indicates the stages of components to which it belong E.g. In case No-36 formula is 542 i.e. 5<sup>th</sup> stage of component I, 4<sup>th</sup> stage of component II and 2<sup>nd</sup> stage of component III.

**Case No-36**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 4 The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No- 38**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 2 Bevel extends inferiorly along ventral border.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No-40**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No- 37**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No- 39**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 4 The rim begins to break down. The face enclosed symphyseal surface is finely grained in texture and becomes smooth and flat and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge.

**Case No- 41**

- 3 Filling-in of grooves and resorption of ridges to form a beginning plateau in the middle third of the dorsal demi- face
- 1 Ventral beveling is present only at superior extremity of ventral border.
- 1 A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.



Formula indicates the stages of components to which it belongs. E.g. In case No-42 formula is 432 i.e. 4<sup>th</sup> stage of component I, 3<sup>rd</sup> stage of component II and 2<sup>nd</sup> stage of component III.

**Case No -42**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No -44**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance

**Case No -47**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
- 1 Ventral beveling is present only at superior extremity of ventral border.
- 1 A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.

**Case No -43**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 4 The rim begins to break down. The face enclosed symphyseal surface is finely grained in texture and becomes smooth and flat and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge.

**Case No -45**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No -48**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 4 The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance



Formula indicates the stages of components to which it belongs. E.g. In case No-50 formula is 543 i.e. 5<sup>th</sup> stage of component I, 4<sup>th</sup> stage of component II and 3<sup>rd</sup> stage of component III.

**Case No -50**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 4 The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
- 3 The symphyseal rim is complete. The irregular or undulating in appearance



Formula indicates the stages of components to which it belongs. E.g. In case No-1 formula is 431 i.e. 4<sup>th</sup> stage of component I, 3<sup>rd</sup> stage of component II and 1<sup>st</sup> stage of component III.

**Case No- 1**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 1 A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.

**Case No- 2**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 4 The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No- 7**

- 3 Filling-in of grooves and resorption of ridges to form a beginning plateau in the middle third of the dorsal demi-face
- 2 Bevel extends inferiorly along ventral border.
- 1 A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.

**Case No- 8**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 5 Further breakdown of the rim (especially along superior ventral edge) and rarefaction of the symphyseal face. There is also disintegration and erratic ossification along the ventral rim.

**Case No- 13**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No- 17**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
- 1 Ventral beveling is present only at superior extremity of ventral border.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.



Formula indicates the stages of components to which it belongs. E.g. In case No-18 formula is 502 i.e. 5<sup>th</sup> stage of component I, 0 stage of component II and 2<sup>nd</sup> stage of component III.

**Case No- 18**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 0 Ventral beveling is absent.
  
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No- 20**

- 4 The plateau, still exhibiting vestiges of billowing, extends over most of the dorsal demi-face.
- 3 The ventral rampart begins by means of bony extension from either or both of the extremities.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No- 27**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
  
- 1 A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.

**Case No- 19**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 4 The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No- 23**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 2 The dorsal rim is complete and the ventral rim is beginning to form. There is no particular beginning site.

**Case No- 46**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 4 The rampart is extensive but gaps are still evident along the earlier ventral border, most evident in the upper two-thirds.
- 1 A partial dorsal rim is present, usually at the superior end of the dorsal margin; it is round elevated above the symphyseal surface.



Formula indicates the stages of components to which it belongs. E.g. In case No-49 formula is 554 i.e. 5<sup>th</sup> stage of component I, 5<sup>th</sup> stage of component II and 4<sup>th</sup> stage of component III.

**Case No- 49**

- 5 Billowing disappears completely and the surface of the entire demi-face becomes flat and slightly granulated in texture.
- 5 The rampart is complete.
- 4 The rim begins to break down. The face enclosed symphyseal surface is finely grained in texture and becomes smooth and flat and the rim is no longer round but sharply defined. There is some evidence of lipping on the ventral edge.

**TABLE NO.I**  
**OBSERVATIONS IN MALE PUBIC SYMPHYSIS BONES**

<b>Case No</b>	<b>Age in years</b>	<b>Component I (Dorsal Demiface) Stage</b>	<b>Component II (Ventral Demiface) Stage</b>	<b>Component III (Symphyseal rim) Stage</b>	<b>Formula</b>	<b>Total score</b>
11	22	4	1	1	411	6
30	22	3	2	1	321	6
31	22	4	1	1	411	6
41	22	3	1	1	311	5
47	22	4	1	1	411	6
4	23	3	3	1	331	7
15	25	4	1	2	412	7
21	25	4	1	2	412	7
28	25	4	3	2	432	9
34	26	4	2	2	422	8
42	26	4	3	2	432	9
9	27	4	3	4	434	11
33	28	4	4	4	444	12
38	28	5	2	2	522	9
5	30	5	5	3	553	13
10	30	5	3	2	532	10
12	30	5	3	2	532	10
26	30	5	3	2	532	10
36	30	5	4	2	542	11
37	30	5	5	3	553	13
40	30	5	5	3	553	13
45	30	5	5	2	552	12
22	32	5	5	4	554	14
39	32	5	5	4	554	14
14	35	5	5	3	553	13
24	35	5	5	3	553	13
32	35	5	4	3	543	12
48	35	5	4	3	543	12
50	35	5	4	3	543	12
16	36	5	5	3	553	13
29	36	5	5	3	553	13
3	38	5	5	3	553	13
6	38	5	5	5	555	15
25	38	5	5	3	553	13
44	38	5	5	3	553	13
43	39	5	5	4	554	14
35	40	5	5	5	555	15

**TOTAL = 37**

**TABLE NO.II****OBSERVATIONS IN FEMALE PUBIC SYMPHYSIS BONES**

<b>Case No</b>	<b>Age in years</b>	<b>Component I (Dorsal Demiface) Stage</b>	<b>Component II (Ventral Demiface) Stage</b>	<b>Component III (Symphyseal rim) Stage</b>	<b>Formula</b>	<b>Total score</b>
7	22	3	2	1	321	6
13	22	3	2	1	321	6
20	26	4	3	2	432	9
23	26	5	5	2	552	12
1	28	4	3	1	431	8
27	28	5	5	1	551	11
2	30	5	4	2	542	11
8	30	5	5	5	555	15
18	30	5	0	2	502	7
46	32	5	4	1	542	10
19	33	5	4	2	542	11
49	33	5	5	4	554	14
17	35	4	1	2	412	7

**TOTAL = 13**

**TABLE NO.III  
COMPARISON OF THE DECEASED AGE WITH MCKERN AND STEWARTS'  
AGE RANGE IN MALES**

<b>Case No</b>	<b>Formula</b>	<b>Total score</b>	<b>Mckern and Stewart's Age range (in years)</b>	<b>Age of deceased (in years)</b>
11	411	6	20-24	22
30	321	6	20-24	22
31	411	6	20-24	22
41	311	5	18-23	22
47	411	6	20-24	22
4	331	7	20-24	23
15	412	7	20-24	25
21	412	7	20-24	25
28	432	9	22-28	25
34	422	8	22-28	26
42	432	9	22-28	26
9	434	11	28-39	27
33	444	12	28-39	28
38	522	9	22-28	28
5	553	13	28-39	30
10	532	10	23-28	30
12	532	10	23-28	30
26	532	10	23-28	30
36	542	11	28-39	30
37	553	13	28-39	30
40	553	13	28-39	30
45	552	12	28-39	30
22	554	14	29+	32
39	554	14	29+	32
14	553	13	28-39	35
24	553	13	28-39	35
32	543	12	28-39	35
48	543	12	28-39	35
50	543	12	28-39	35
16	553	13	28-39	36
29	553	13	28-39	36
3	553	13	28-39	38
6	555	15	36+	38
25	553	13	28-39	38
44	553	13	28-39	38
43	554	14	29+	39
35	555	15	36+	40

**TABLE NO.IV****COMPARISON OF THE DECEASED AGE WITH MCKERN AND STEWART'S AGE RANGE IN FEMALES**

<b>Case No</b>	<b>Formula</b>	<b>Total score</b>	<b>Mckern and Stewart's Age range (in years)</b>	<b>Age of deceased (in years)</b>
7	321	6	20-24	22
13	321	6	20-24	22
20	432	9	22-28	26
23	552	12	28-39	26
1	431	8	22-28	28
27	551	11	28-39	28
2	542	11	28-39	30
8	555	15	36+	30
18	502	7	20-24	30
46	542	10	23-28	32
19	542	11	28-39	33
49	554	14	29+	33
17	412	7	20-24	35

**STATISTICAL APPROACH TO THE PRESENT STUDY**

**MEAN:** It is the arithmetic average or arithmetic mean, obtained by summing up the measurements and dividing the total by the number of measurements.

Formula for calculation of mean

$$\text{MEAN} = \frac{\text{Total or sum of the observations}}{\text{Number of observation}}$$

$$X = \frac{S(X_1+X_2+X_n)}{n} = \frac{SX}{n}$$

X = Mean of series.

N = Number of observation

S = Sum of observation.

X= Series of observation.

X<sub>1</sub> , X<sub>2</sub>, X<sub>n</sub> – Indicates individual reading.

For example- there are 3 cases (1 case of 23 years, 2cases of 25 years) in the age group 23 –25 years against score 7, mean is calculated by applying above method.

$$X = \frac{23+50}{3} = \frac{73}{3} = 24.33$$

In this manner, mean was calculated for all age groups of this study.

**STANDARD DEVIATION:** The sum of the squares of the deviation from the arithmetic mean divided by the number of terms (observations) in the series gives the square of the standard deviation (S.D)

$$\text{S.D. of } n = \sqrt{\frac{\text{Sum of } X^2 \text{ values} - (\text{mean})^2}{\text{No of observations}}} = \sqrt{\frac{X^2 - (\bar{X})^2}{n}}$$

$X^2$  = Square of series of observation

$(\bar{X})^2$  = Square of mean

n = Number of observations.

For example – standard deviation for score 7 are calculated as follows:

Mean is 24.33 for 3 cases (1 case of 23 years, 2 cases of 25 years) against score 7.

Square of 23 = 529.    Number of cases 1 = 529

Square of 25 = 625.    Number of cases 2 = 1250

Total = 1779

Number of observations = 3

Square of mean = 24.33 X 24.33 = 591.94

S.D = 1779 – 591.94

3

= 1.06

= 1.02

In this manner, standard deviation was calculated for all age groups against scores of this study.

**TABLE No. V**

**CALCULATED MEAN AGE, STANDARD DEVIATION AND AGE RANGES  
FOR THE TOTAL SCORES OF SYMPHYSEAL FORMULA OF MALE  
CASES**

<b>Total Score</b>	<b>No of cases</b>	<b>Age range (in years)</b>	<b>Mean</b>	<b>S.D</b>
<b>4-5</b>	1	22	22	-
<b>6-7</b>	7	22-25	23	1.30
<b>8-9</b>	4	25-28	26.25	1.09
<b>10</b>	3	30	30	-
<b>11-13</b>	17	27-38	33.29	3.61
<b>14</b>	2	32	32	-
<b>15</b>	3	38-40	39	0.81

**TABLE No. VI**

**CALCULATED MEAN AGE, STANDARD DEVIATION AND AGE RANGES  
FOR THE TOTAL SCORES OF SYMPHYSEAL FORMULA OF FEMALE  
CASES**

<b>Total Score</b>	<b>No of cases</b>	<b>Age range (in years)</b>	<b>Mean</b>	<b>S.D</b>
<b>6-7</b>	4	22-35	27.25	5.53
<b>8-9</b>	2	26-28	27	1.00
<b>10</b>	1	32	32	-
<b>11-13</b>	4	26-33	29.25	2.58
<b>14</b>	1	33	33	-
<b>15</b>	1	30	30	-

TABLE No.VII									
AGE LIMITS OF COMPONENT STAGES OF MALES IN DIFFERENT INDIAN STUDIES									
IN THE PRESENT STUDY				IN HARIKRISHNA'S STUDY			BHOOTRA'S STUDY		
Stage	No of cases	Age range (in years)	Mean	No of cases	Age range (in years)	Mean	No of cases	Age range (in years)	Mean
<b>COMPONENT I</b>				<b>COMPONENT I</b>			<b>COMPONENT I</b>		
<b>0</b>	-	-	-	2	-16	16.00	2	-16	16.00
<b>I</b>	-	-	-	3	17-18	17.33	3	17-18	17.33
<b>II</b>	-	-	-	2	19-20	19.50	6	18-22	19.66
<b>III</b>	3	22-23	22.23	3	19-24	21.50	11	19-22	20.54
<b>IV</b>	10	22-28	24.8	5	22-24	23.20	5	20-24	23.00
<b>V</b>	24	28-40	33.75	63	25+	37.44	70	25+	36.31
<b>COMPONENT II</b>				<b>COMPONENT II</b>			<b>COMPONENT II</b>		
<b>0</b>	-	-	-	6	16-20	17.33	13	16-20	18.69
<b>I</b>	6	22-25	23	3	19-22	20.00	9	19-22	20.33
<b>II</b>	3	22-28	25.33	1	24	24.00	2	22-24	23.00
<b>III</b>	7	23-30	27.28	7	22-26	24.00	4	22-25	24.00
<b>IV</b>	5	28-35	32.6	13	23-35	26.92	6	25-30	26.22
<b>V</b>	16	30-40	33.12	47	25+	47.70	63	25+	38.22
<b>COMPONENT III</b>				<b>COMPONENT III</b>			<b>COMPONENT III</b>		
<b>0</b>	-	-	-	10	16-22	18.60	24	16-23	20.46
<b>I</b>	6	22-23	22.16	10	23-26	24.70	8	24-25	24.62
<b>II</b>	11	25-30	27.72	12	23-35	26.52	15	25-30	27.06
<b>III</b>	13	30-38	34.69	14	25-40	34.29	13	25-35	30.00
<b>IV</b>	4	27-32	29.75	24	35-56	42.58	26	35-53	39.26
<b>V</b>	3	38-40	39	7	40+	57.85	21	45+	54.54

<b>TABLE No.VIII</b>									
<b>AGE LIMITS OF COMPONENT STAGES OF FEMALES IN DIFFERENT INDIAN STUDIES</b>									
<b>IN THE PRESENT STUDY</b>				<b>IN HARIKRISHNA'S STUDY</b>			<b>BHOOTRA'S STUDY</b>		
<b>Stage</b>	<b>No of cases</b>	<b>Age range (in years)</b>	<b>Mean</b>	<b>No of cases</b>	<b>Age range (in years)</b>	<b>Mean</b>	<b>No of cases</b>	<b>Age range (in years)</b>	<b>Mean</b>
<b>COMPONENT I</b>				<b>COMPONENT I</b>			<b>COMPONENT I</b>		
<b>0</b>	-	-	-	4	17-20	18.00	9	17-23	18.88
<b>I</b>	-	-	-	8	18-21	19.13	5	19-25	22.80
<b>II</b>	-	-	-	4	20-23	21.50	3	20-22	21.33
<b>III</b>	2	22	22	1	24	24.00	1	26	26.00
<b>IV</b>	3	26-35	29.66	6	25-30	27.33	2	30	30.00
<b>V</b>	8	26-33	30.25	15	28+	40.47	9	32+	41.44
<b>COMPONENT II</b>				<b>COMPONENT II</b>			<b>COMPONENT II</b>		
<b>0</b>	1	30	30	13	17-21	18.69	13	17-23	19.46
<b>I</b>	1	35	35	3	21-23	22.00	4	22-25	23.75
<b>II</b>	2	22	22	1	24	24.00	1	26	26.00
<b>III</b>	2	26-28	27	3	25-28	26.00	-	-	-
<b>IV</b>	3	30-33	31.66	4	26-30	29.00	2	30	30.00
<b>V</b>	4	26-35	30.4	14	28+	41.21	9	32+	41.44
<b>COMPONENT III</b>				<b>COMPONENT III</b>			<b>COMPONENT III</b>		
<b>0</b>	-	-	-	16	17-23	19.31	17	17-25	20.47
<b>I</b>	4	22-28	25	4	24-30	26.25	1	26	26.00
<b>II</b>	7	26-35	30.28	8	25-31	28.63	2	30	30.00
<b>III</b>	-	-	-	3	30-35	33.23	4	32-40	46.25
<b>IV</b>	1	33	33	4	40-50	45.00	3	40-45	43.33
<b>V</b>	1	30	30	3	52+	60.33	2	46	48.00

**TABLE No. IX**  
**AGE LIMITS OF COMPONENT STAGES OF MALES IN DIFFERENT STUDIES**

IN THE PRESENT STUDY				IN HARIKRISHNA's STUDY			BHOOTRA'S STUDY			MCKERN AND STEWART'S METHOD '57'	
Stage	No of cases	Age range (in years)	Mean	No of cases	Age range (in years)	Mean	No of cases	Age range (in years)	Mean	Age range (in years)	mode
<b>COMPONENT I</b>				<b>COMPONENT I</b>			<b>COMPONENT I</b>			<b>COMPONENT I</b>	
<b>0</b>	-	-	-	2	-16	16.00	2	-16	16.00	17 – 18	17.00
<b>I</b>	-	-	-	3	17-18	17.33	3	17-18	17.33	18 – 21	18.00
<b>II</b>	-	-	-	2	19-20	19.50	6	18-22	19.66	18 – 21	19.00
<b>III</b>	3	22-23	22.23	3	19-24	21.50	11	19-22	20.54	18 – 24	20.00
<b>IV</b>	10	22-28	24.8	5	22-24	23.20	5	20-24	23.00	19 – 29	23.00
<b>V</b>	24	28-40	33.75	63	25+	37.44	70	25+	36.31	23+	31.00
<b>COMPONENT II</b>				<b>COMPONENT II</b>			<b>COMPONENT II</b>			<b>COMPONENT II</b>	
<b>0</b>	-	-	-	6	16-20	17.33	13	16-20	18.69	17 – 22	19.00
<b>I</b>	6	22-25	23	3	19-22	20.00	9	19-22	20.33	19 – 23	20.00
<b>II</b>	3	22-28	25.33	1	24	24.00	2	22-24	23.00	19.0 – 24	22.00
<b>III</b>	7	23-30	27.28	7	22-26	24.00	4	22-25	24.00	21 – 28	23.00
<b>IV</b>	5	28-35	32.6	13	23-35	26.92	6	25-30	26.22	22 – 33	26.00
<b>V</b>	16	30-40	33.12	47	25+	47.70	63	25+	38.22	24 +	32.00
<b>COMPONENT III</b>				<b>COMPONENT III</b>			<b>COMPONENT III</b>			<b>COMPONENT III</b>	
<b>0</b>	-	-	-	10	16-22	18.60	24	16-23	20.46	17 – 24	19.00
<b>I</b>	6	22-23	22.16	10	23-26	24.70	8	24-25	24.62	21 – 28	23.00
<b>II</b>	11	25-30	27.72	12	23-35	26.52	15	25-30	27.06	24 – 32	27.00
<b>III</b>	13	30-38	34.69	14	25-40	34.29	13	25-35	30.00	24 – 39	28.00
<b>IV</b>	4	27-32	29.75	24	35-56	42.58	26	35-53	39.26	29 +	35.00
<b>V</b>	3	38-40	39	7	40+	57.85	21	45+	54.54	38 +	-

**TABLE No. X**  
**AGE LIMITS OF COMPONENT STAGES OF FEMALES IN DIFFERENT STUDIES**

IN THE PRESENT STUDY				IN HARIKRISHNA's STUDY			BHOOTRA'S STUDY			MCKERN AND GILBERT'S METHOD '73'	
Stage	No of cases	Age range (in years)	Mean	No of cases	Age range (in years)	Mean	No of cases	Age range (in years)	Mean	Age range (in years)	mode
<b>COMPONENT I</b>				<b>COMPONENT I</b>			<b>COMPONENT I</b>			<b>COMPONENT I</b>	
<b>0</b>	-	-	-	4	17-20	18.00	9	17-23	18.88	14-24	18.00
<b>I</b>	-	-	-	8	18-27	19.13	5	19-25	22.80	13-25	20.00
<b>II</b>	-	-	-	4	20-23	21.50	3	20-22	21.33	18-40	29.8
<b>III</b>	2	22	22	1	24	24.00	1	26	26.00	22-40	31.00
<b>IV</b>	3	26-35	29.66	6	25-30	27.33	2	30	30.00	28-59	40.80
<b>V</b>	8	26-33	30.25	15	28+	40.47	9	32+	41.44	33-59	48.00
<b>COMPONENT II</b>				<b>COMPONENT II</b>			<b>COMPONENT II</b>			<b>COMPONENT II</b>	
<b>0</b>	1	30	30	13	17-21	18.69	13	17-23	19.46	13-22	18.6
<b>I</b>	1	35	35	3	21-23	22.00	4	22-25	23.75	16-40	22.5
<b>II</b>	2	22	22	1	24	24.00	1	26	26.00	18-40	29.6
<b>III</b>	2	26-28	27	3	25-28	26.00	-	-	-	27-57	38.8
<b>IV</b>	3	30-33	31.66	4	26-30	29.00	2	30	30.00	21-58	40.9
<b>V</b>	4	26-35	30.4	14	28+	41.21	9	32+	41.44	36-59	48.5
<b>COMPONENT III</b>				<b>COMPONENT III</b>			<b>COMPONENT III</b>			<b>COMPONENT III</b>	
<b>0</b>	-	-	-	16	17-23	19.31	17	17-25	20.47	13-25	20.2
<b>I</b>	4	22-28	25	4	24-30	26.25	1	26	26.00	18-34	21.8
<b>II</b>	7	26-35	30.28	8	25-31	28.63	2	30	30.00	22-40	32.0
<b>III</b>	-	-	-	3	30-35	33.33	4	32-40	46.25	22-57	35.1
<b>IV</b>	1	33	33	4	40-50	45.00	3	40-45	43.33	21-58	39.9
<b>V</b>	1	30	30	3	52+	60.33	2	46+	48.00	36-59	49.4

**TABLE NO. XI**  
**COMPARISON OF CALCULATED MEAN AGE, STANDARD DEVIATION AND AGE RANGES FOR THE TOTAL SCORES OF SYMPHYSEAL FORMULA OF MALE WITH DIFFERENT STUDIES**

<b>IN THE PRESENT STUDY</b>					<b>HARIKRISHNA'S STUDY</b>				<b>MCKERN AND STEWART'S METHOD '57'</b>		
<b>Total Score</b>	<b>No of cases</b>	<b>Age range (in years)</b>	<b>Mean</b>	<b>S.D</b>	<b>No of cases</b>	<b>Age range (in years)</b>	<b>Mean</b>	<b>S.D</b>	<b>Age range (in years)</b>	<b>Mean</b>	<b>S.D</b>
<b>0</b>	-	-	-	-	2	16	16.00	-	-17	17.29	.49
<b>1-2</b>	-	-	-	-	4	17-20	18.00	1.28	17-20	19.04	.79
<b>3</b>	-	-	-	-	1	19	19.00	-	18-21	19.79	.85
<b>4-5</b>	1	22	22	-	2	19-22	20.50	1.50	18-23	20.84	1.13
<b>6-7</b>	7	22-25	23	1.30	2	22-24	23.00	1.00	20-24	22.42	.99
<b>8-9</b>	4	25-28	26.25	1.09	7	23-26	24.29	0.93	22-28	24.14	1.93
<b>10</b>	3	30	30	-	4	25-26	25.25	0.44	23-28	26.05	1.87
<b>11-13</b>	17	27-38	33.29	3.61	24	25-40	31.46	4.79	28-39	29.18	3.33
<b>14</b>	2	32	32	-	24	35-56	42.58	6.97	29+	35.84	3.89
<b>15</b>	3	38-40	39	0.81	7	40+	57.86	8.37	36+	41.00	6.22

**TABLE NO.XII**  
**COMPARISON OF CALCULATED MEAN AGE, STANDARD DEVIATION AND AGE RANGES FOR THE TOTAL SCORES OF SYMPHYSEAL FORMULA OF FEMALES WITH DIFFERENT STUDIES**

IN THE PRESENT STUDY					HARIKRISHNA'S STUDY				MCKERN AND STEWART'S METHOD '57'		
Total Score	No of cases	Age range (in years)	Mean	S.D	No of cases	Age range (in years)	Mean	S.D	Age range (in years)	Mean	S.D
0	-	-	-	-	4	17-18	18.00	1.22	-17	17.29	.49
1-2	-	-	-	-	9	18-20	19.23	0.88	17-20	19.04	.79
3	-	-	-	-	3	21-23	22.00	0.82	18-21	19.79	.85
4-5	-	-	-	-	-	-	-	-	18-23	20.84	1.13
6-7	4	22-35	27.25	5.53	1	24	24.00	-	20-24	22.42	.99
8-9	2	26-28	27	1.00	5	25-30	26.50	3.44	22-28	24.14	1.93
10	1	32	32	-	1	30	30.00	-	23-28	26.05	1.87
11-13	4	26-33	29.25	2.58	8	28-35	30.75	2.64	28-39	29.18	3.33
14	1	33	33	-	4	40-50	45.00	5.00	29+	35.84	3.89
15	1	30	30	-	3	52+	60.33	6.58	36+	41.00	6.22

**TABLE No. XIII**

**COMPARISON OF CALCULATED MEAN AGE, STANDARD DEVIATION  
AND AGE RANGES FOR THE TOTAL SCORES OF SYMPHYSEAL  
FORMULA OF FEMALE WITH MCKERN AND GILBERT' S '73' STUDY**

<b>IN THE PRESENT STUDY</b>					<b>MCKERN AND GILBERT' S METHOD '73'</b>
<b>Total Score</b>	<b>No of cases</b>	<b>Age range (in years)</b>	<b>Mean</b>	<b>S.D</b>	<b>Age range (in years)</b>
<b>0</b>	-		-	-	14-18
<b>1</b>	-	-	-	-	13-24
<b>2</b>	-	-	-	-	16-25
<b>3</b>	-	-	-	-	18-25
<b>4-5</b>	-	-	-	-	22-29
<b>6</b>	2	22	22	-	25-36
<b>7-8</b>	3	28-35	31	1.00	23-39
<b>9</b>	1	26	26	-	22-40
<b>10-11</b>	4	28-33	30.75	1.92	30-47
<b>12</b>	1	26	26	-	32-52
<b>13</b>	-	33	33	-	44-54
<b>14-15</b>	2	30-33	31.5	1.5	52-59

Various parameters are used to assess age of which estimation from skeletal remains is fairly accurate as well as can be used even years after death as they resist putrefaction. They are still useful even if the fragments are recovered. This estimation of age from bones has been more accurate till 2<sup>nd</sup> decades of life and as age increases variation also increases. To reduce this variation large number of studies has been done on pubic symphysis as an indicator of age and has been found more useful when compared to other available methods.

It was Todd (1920) who made an early and significant contribution in this field of age determination from pubic symphysis. He established ten phases of pubic age ranging from the age group 18-19 years to 50+ years and stated that determination of age after 2<sup>nd</sup> decade can be fairly accurately estimated by examining changes.

McKern and Stewart (1957) made useful revisions to Todd's criteria. They presented three components of pubic symphysis each with five developmental stages. The components and their stages are calculated to give a total score ranging from 0 to 15. They observed a steady, uniform age progression in all three components. The total score is used to derive age from the appropriate tables (Table No.1).

The maturity process of pubic bones in females differs from that of males. Todd (1921) developed a series of ten phases for females. Gilbert and McKern (1973) devised a standard for ageing female pubis for the age group 17-55 years (Table No.3) similar to the one developed by McKern and Stewart (1957) for males.

For the present study a total number of 50 human pubic bones were collected from dead bodies brought for medicolegal autopsies in the mortuary of Department of Forensic Medicine & Toxicology, KLE University's Jawaharlal Nehru Medical

College, Belgaum. The dead bodies from which the bones were collected were of known ages between 20-40 years. Out of these 37 were males and 17 were females.

### **FINDINGS IN SYMPHYSEAL SURFACE IN MALES (Table No.VII)**

#### **COMPONENT –I (DORSAL DEMIFACE)**

First site to show developmental morphological changes is the dorsal demiface. Stage 0 (ridges and grooves are very prominent) is not seen. Stage I (filling of grooves dorsally and formation of dorsal margin in middle one third) is not seen. Stage II (dorsal margin is complete) is not seen. Stage III (dorsal plateau is seen in middle third) was observed in 3 cases with an age range of 22-23 years (mean 22.33). Stage IV (the plateau still exhibiting vestiges of billowing extends over the dorsal demiface) was observed in 10 cases with an age range of 22-28 years (mean 24.80). Stage V (dorsal demiface is flat) was observed in 24 cases with an age range of 28-40 years (mean 33.75).

When compared each stages of component I age range in the present study with standard Mckern and Stewart's study (Table No IX), it revealed within the age range of their study.

When compared with Harikrishna's and Bhootra's study (Table No VII), stage IV was delayed for 4 years with an age range of 22-28 years.

#### **COMPONENT –II (VENTRAL DEMIFACE)**

After dorsal demiface it is next in development to show metamorphic changes. Stage I ( ventral bevelling is present at superior extremity of ventral border) was observed in 6 cases with an age range of 22-25 years (mean 23). Stage II (ventral bevelling along the entire ventral border) was observed in 3 cases with an age range

of 22-28 years (mean 25.33). Stage III (bony extensions from either or both extremities start to form ventral rampart) was observed in 7 cases with an age range of 23-30 years (mean 27.28). Stage IV (ventral rampart is extensive but gaps are still evident in upper two thirds along the ventral border) was observed in 5 cases with an age range of 28-35 years (mean 32.6). Stage V (ventral rampart is complete) was observed in 16 cases with an age range of 30-40 years (mean 33.12).

When compared each stages of component II age range in the present study with standard Mckern and Stewart's study (Table No IX), it revealed 2 years delay for stage I, III and IV and 4 years delay in stage II. But stage V falls within age range of their study.

When compared with Harikrishna's study (Table No VII), stage I is delayed for 3 years and stage II and stage III delayed for 4 years. Age ranges in stages IV and V has corresponded to this study.

When compared with Bhootra's study (Table No VII), stage I is delayed for 3 years and stage II delayed for 4 years. Stage III and IV delayed for 5 years. But age range in stage V has corresponded to this study.

### **COMPONENT –III (SYMPHYSEAL RIM)**

It is next in development to ventral demiface. Stage I (dorsal rim is partially formed) was observed in 6 cases with an age range of 22-23 years (mean 22.16). Stage II (dorsal rim is completely formed) was observed in 11 cases with an age range of 25-30 years (mean 27.72). Stage III (symphyseal rim is complete) was observed in 13 cases with an age range of 30-38 years (mean 34.69). Stage IV (symphyseal rim begins to thin out or breakdown) was observed in 4 cases with an age range of 27-32

years (mean 29.75). Stage V (rarefaction of symphyseal face and further breakdown of symphyseal rim) was observed in 3 cases with an age range of 38-40 years (mean 39).

When compared each stages age range in the present study with standard Mckern and Stewart's study (Table No IX), it revealed within the age range of their study except in stage IV which has appeared 2 years earlier.

When compared with Harikrishna's and Bhootra's study (Table No VII), in stage III the age range was 2 years earlier and 3 years delayed respectively. In stage V it appeared 2 years and 7 years earlier respectively. But this stage corresponded to Mckern and Stewart's method.

The total score for individual cases was compared to standard Mckern and Stewart's age range (Table No.III). The total score was started from 5 as the pubic bones selected were of individuals of 2<sup>nd</sup> and 3<sup>rd</sup> decades of life. Age estimation from the total score 7 (23-25 years) was +1 year and for total score 10 (30 years) was +2 years and other scores falls within the range.

The total score was compared to standard Mckern and Stewart's age range. For the total score 10 (30 years) was +2 years and for other total score it falls within the age range.

The same was compared to Harikrishna's (Table No.XI) age range, for total score 6-7 (22-24 years) was +1year, for the total score 10 (30 years) was +4 years, for total score 15 (38-40 years) was started by 38 years, which was same as standard method of Mckern and Stewart's. But in his study for total score 15 (40+ years) was +2 years delayed compared to present study.

Following are the 15 symphyseal formula obtained from male pubic symphyseal surface as compared to Mckern and Stewarts'21 symphyseal formulae:-

311    321    331    411    412    422    432    434    444    522  
532    542    552    554    555

### **FINDINGS IN THE SYMPHYSEAL SURFACE IN FEMALES (Table No. VIII)**

#### **COMPONENT –I (DORSAL DEMIFACE)**

There are no cases in Stage 0, I and II in our study. Stage III was observed in 2 cases with an age of 22 years (mean 22). Stage IV was observed in 3 cases with an age range of 26-35 years (mean 29.66). Stage V was observed in 8 cases with an age range of 26-33 years (mean 30.25).

When compared each stages of component I age range in the present study with Harikrishna's and Bhootra's study (Table No.VIII), for the stage III age was delayed for 2 years and 4 years respectively. For stage IV age was delayed for 5 years. For stage V age was 2 years and 6 years earlier.

Comparing our component age range (Mckern and Stewart's method) study to that of Mckern and Gilbert's (Table No.X), the age range falls within.

#### **COMPONENT –II (VENTRAL DEMIFACE)**

Stage 0 was observed in 1 case with an age of 30 years. Stage I was observed in 1 case with an age of 35 years. Stage II was observed in 2 cases with an age of 22 years. Stage III was observed in 2 cases with an age range of 26-28 years (mean 27 years). Stage IV was observed in 2 cases with an age range of 26-35 years (mean

29.66 years). Stage V was observed in 2 cases with an age range of 26-33 years (mean 30.25 years).

When compared each stages of component II age range in the present study with Harikrishna's and Bhootra's study (Table No.VIII), for the stage 0 age was delayed for 9 and 7 years respectively. For stage I age was delayed for 8 and 10 years respectively. For stage II age was earlier for 2 and 4 years respectively. For stage IV age was delayed for 3 years. For stage V age was 2 and 6 years earlier respectively.

Comparing our component age range (Mckern and Stewart's method) study to that of Mckern and Gilbert's (Table No.X); the age range falls within except the stage I which is delayed for 8 years.

### **COMPONENT –III (SYMPHYSEAL RIM)**

There are no cases in stage 0 in our study. Stage I was observed in 4 cases with an age range of 22-28 years (mean 25 years). Stage II was observed in 7 cases with an age range of 26-35 years (mean 30.25 years). In Stage III no case was seen. Stage IV was observed in 1 case with an age of 33 years. Stage V was observed in 1 case with an age of 30 years.

When compared each stages of component III age range in the present study with Harikrishna's and Bhootra's study (Table No.VIII), the stage V age was earlier for 22 and 16 years respectively.

Comparing our component age range (Mckern and Stewart's method) study to that of Mckern and Gilbert's (Table No.X), the age range falls within.

On comparing the total score for individual cases to standard Mckern and Stewart's age range (Table No.IV) age estimation from the total score 7 (30-35years)

was 10 years earlier and 11 years delayed. For total score 10 (32 years) was +4 years and other scores falls within the range.

The total score was compared to standard Mckern and Stewart's age range, for the total score 6-7 (22-35 years) was +11 years, for the total score 10 (32 years) was +4 years, for the total score 15 (32 years) was 6 years earlier. For other total scores it falls within the age range.

The total score was compared to standard Mckern and Gilbert's age range, it falls within the age range.

Following are the 10 symphyseal formulas obtained from female pubic symphyseal surface as compared to Mckern and Stewart's 21 different formulae:-

321    412    431    432    501    542    551    552    554    555

As per Todd's (1921a:26)<sup>16</sup> "race has strikingly little influence upon pubic metamorphosis".

As per the study done in Japan the age changes in pubic bone of Japanese individuals were 2-3 years earlier<sup>22</sup> which was same in our study too.

As per the study done in US (1955) estimates in males had a high correlation with known age whereas females were a bit lower<sup>23</sup> which was same in our study.

In a study (1957) concluded that "assessment of age of females by the pubic symphysis cannot be as accurate as in the case of males. So it is necessary to be more cautious in applying male pubic standards to female."<sup>29</sup> In our study also it was more accurate in males than compared to females.

In a study (1973) done in US, male pubic standards of Mckern and Stewart (1957) was not applicable for female pubic symphysis as they found that there were significant differences in male and female patterns and developed a system to respond to them. A very important difference is in the symphyseal rim. "In males the symphyseal rim encloses both dorsal and ventral demi-faces; in females it separates the two." Ignoring this factor would cause the user of the Mckern-Stewart method to define the ventral rampart differently and, thus, decrease their accuracy. They demonstrated that females are absolutely different from males, in the rate and locality of age related metamorphic changes in the pubis.<sup>30</sup> In our study also we noted the similar difference between male and female symphyseal rim, but on careful observation the age range in females were higher in younger age group.

As per the researches done at Hyderabad (1975<sup>31</sup> and 1985<sup>38</sup>), males age estimation by Mckern and Stewart method was more accurate in the younger age group (16-35 years). It gave indication of age within the range of 5-6 years and after that the changes in pubic bone show a long variation in age estimation. In females age estimation was more accurate in higher age group (32-50 years) than younger age group. In our study it was accurate in the age group (20-40years) in males, but in females less accurate.

A study done in New Delhi (1995) revealed that the variations observed in the progression of metamorphic features could be attributed to environmental and diet factors.<sup>47</sup>

On comparing the present study with the study done in Govt Medical College, Amritsar, Punjab, age estimation from different components in males and females up to the total score of 10 (23-28 years) was +2 in males and  $\pm 7$  in females and  $\pm 6$  years

for both males and females respectively. Whereas for the score above 10 the estimated age was within the range in our study, but  $\pm 12$  in males and  $\pm 9$  in females was in Punjab study.<sup>48</sup>

As per the study done in East Delhi, the Mckern-Stewart criteria can be equally useful in estimation of age for Indian population also. Based on the Mckern-Stewart's criteria up to the accuracy of +1 year in the age group of 20-30 years, +5 years in the age group of 30-40 years and +8 years in the age group of 40-50 years.<sup>52</sup> As per our study Mckern and Stewart's criteria can be utilized accurately in India for males when compared to females.

A study conducted in Tirupathi (AP) revealed that the age estimation in males by Mckern and Stewart's method (1957) was accurate up to the age of 35 years only. For females Mckern and Gilbert's method (1973) was accurate up to 60 years of age.<sup>53</sup> In our study it was more accurate in males of age group (20-40 years) and less accurate in females.

Age determination has been a time honoured problem in forensic medicine. It is one of the most important criteria for identity in the dead. After the second decade of life, the pubic symphyseal aging is one of the most important tools. It was Todd (1920) who made an early and significant contribution to age determination from pubic symphysis. Todd established 10 phases of pubic symphysis ranging from the age group 18-19 years to 50+years. Mckern and Stewart (1957) made very useful revisions in this field. In males, they presented three components of pubic symphysis (dorsal plateau, ventral rampart and symphyseal rim) each with five developmental stages. The components and the stages may be used to give a total score ranging from 0 to 15. They presented age ranges and mean age for the total score.

The maturity process of the pubic bones in the female differs from those of males. Gilbert and Mckern (1973) devised a standard for ageing female symphysis of the age group 17-55 years. As in males they presented three components with five developmental stages. The influence of birth trauma in age determination from pubic symphysis was mentioned by Stewart (1957).

The following conclusions are drawn from the present study of age estimation from pubic symphysis:-

1. Age can be estimated by the study of metamorphosis of os pubis based on the Mckern-Stewart's criteria up to the accuracy of +2 year in the age group of 20-30 years, +3 years in the age group of 30-40 years in males and in females it's not useful.
2. It can be useful by using Mckern and Stewart's criteria and calculating the total scores for females as per the Mckern and Gilbert's (1973) criteria.

3. The morphological changes of the pubic symphysis started late in present study (North Karnataka) as compared to the Mckern-Stewart's study (American population). This difference may be due to the continental or regional variation.
4. In present study, it was found that one set of morphological changes in all the 3 components is delayed by 3 years as compared to the study conducted by Sinha in the year 1991 on male Delhi population. This delay of 3 years may be due to changes in factors like climatic, dietetic and life style etc of individual staying in Delhi.
5. Approximate age of individual can be assessed by just studying the morphological changes in any component of symphysis pubis defined by Mckern-Stewart's criteria but for accurate assessment of ages, changes in all the three components should be taken into consideration.
6. After comparing the present study with the other researchers in the subject, it can be concluded that there is a significant variation in morphological changes of pubic symphysis, therefore for age estimation the latest data available of that region should be used for more accurate estimation of age.
7. Our study correlates more with Harikrishna's and Bhootra's study because South Indian population seems to be of common origin and is different from Northern parts of India.
8. It is observed from the present study and review of literature that the accuracy of age determination from Mckern and Stewart's criteria is more in Hyderabad population followed by North Karnataka, Punjab, and Delhi.

The present study is a cross sectional study conducted in the department of Forensic Medicine and Toxicology, KLE University's J. N. Medical College, Belgaum, during one year period from 1<sup>st</sup> Nov 2007 to 31<sup>st</sup> Oct 08. In this period a total No of 50 pubic Symphysis bones were collected from the autopsied cases aged between 20-40 years for estimation of age.

The purpose of the study was to know the accuracy of Mckern and Stewart's criteria in 2<sup>nd</sup> and 3<sup>rd</sup> decades of life in North Karnataka region.

The predesigned and pretested proforma was used to collect the required data and following were the findings:-

1. Out of 50 cases 37 (74%) were male out of which 22 (59.45%) cases are of 2<sup>nd</sup> and 15 (40.54%) cases from 3<sup>rd</sup> decades of life.
2. In total 50 cases, females were 13 (26%) cases out of which 9 (69.23%) cases were of 2<sup>nd</sup> and 4 (30.76%) cases from 3<sup>rd</sup> decades of life.
3. On comparing the individual cases of male age with the Mckern and Stewart's age range, it falls within the age range except in the age of 25 which is +1 year and in age 30 which is 2 years delayed.
4. In females, while comparing the same, it has not corresponded.
5. On comparing the component wise with Harikrishna's and Bhootra's components, the age range is almost same except in component II which is +5 years.
6. On comparing the present study with the Mckern and Stewart's criteria scores, all scores are within age range except in total score 6-7 and 10 which is +1 year and +2 years respectively.

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