"TO COMPARE EFFICACY OF TRANSDERMAL DICLOFENAC 200MG WITH CONVENTIONAL ANALGESIA – IV PARACETAMOL IN POST OPERATIVE PAIN MANAGEMENT AFTER LAPAROSCOPIC APPENDICECTOMY- A RANDOMISED CONTROL TRIAL."

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In

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KAHER, BELAGAVI, 590010, KARNATAKA.

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DR. S. C. METGUD,
M.S. General Surgery,
Professor and Head,
Department of General Surgery,
J. N. Medical College,
Belagavi

Date: 26/03/2025
Place: Belagavi

KAHER BELAGAVI J.N. MEDICAL COLLEGE

DR. N.S. MAHANTASHETTI,
MD Pediatrics,
Principal,
J. N. Medical College,
Belagavi

PRINCIPAL
Jawaharlal Nehru Medical College
BELAGAVI

Date: 26/03/2025
Place: Belagavi

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Accredited 'A+' Grade by NAAC (3rd Cycle) **Placed in Category 'A' by MoE (GoI)**

Nehru Nagar, Belagavi- 590 010, Karnataka, INDIA

0831 - 2471350 0831 - 2470759 www.jnmc.edu principal@jnmc.edu

Ref No: MDC/PG/ Date: 17-03-2025

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Chairperson-Antiplagiarism Committee &
Principal,
J. N. Medical College, Belagavi.

To,
Reg. No. BH0122014
Postgraduate Student,
2022-23 Batch,
Department of General Surgery
J. N. Medical College, Belagavi.

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JNMC INSTITUTIONAL ETHICS COMMITTEE
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
Website: http//www.jnmc.edu
E-Mail : dome@jnmc.edu
Phone: (+ 91-(0)831 Office : 2472550
Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref No.MDC/JNMCIEC/ 114 **Date: 25/03/2023**

To

Reg.no. BH0122014

PG Student in General Surgery
J. N. Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"TO COMPARE EFFICACY OF TRANSDERMAL DICLOFENAC (NU PATCH 200MG) WITH CONVENTIONAL ANALGESIA IN POST OPERATIVE PAIN MANAGEMENT AFTER LAPAROSCOPIC APPENDICECTOMY- A RANDOMISED CONTROL TRAIL",** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee.

(Dr. Smita Sonoli)
Member Secretary
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi.

(Dr. Harsha Hegde)
Chairman,
JNMC Institutional Ethics Committee
J.N.Medical College, Belagav

LIST OF ABBREVIATIONS:

NSAIDs – Non-Steroidal Anti-Inflammatory Drugs

COX – Cyclo-Oxygenase

RLQ – Right Lower Quadrant

ASIS – Anterior Superior Iliac Spine

SMV – Superior Mesenteric Vein

GALT – Gut-Associated Lymphoid Tissue

CO_2 – Carbon Dioxide

VAS – Visual Analog Scale

PCA – Patient-Controlled Analgesia

NRS – Numeric Rating Scale

TAP – Transversus Abdominis Plane

CBT – Cognitive-Behavioral Therapy

CONSORT – Consolidated Standards of Reporting Trials

SAE – Serious Adverse Events

USG – Ultrasonography

CT – Computed Tomography

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ABSTRACT

Background: Effective postoperative pain management is pivotal for patient comfort, faster recovery, and reduced morbidity. Laparoscopic appendicectomy, though minimally invasive, can still result in moderate to severe postoperative pain. Conventional IV paracetamol provides adequate analgesia but may require repeated administration. Transdermal diclofenac offers a potentially favourable alternative by maintaining stable plasma levels and bypassing first-pass metabolism.

Methods: This randomized controlled trial enrolled 112 patients (18–40 years) undergoing laparoscopic appendicectomy. Participants were randomized into two groups of equal size (n=56 each): the experimental group received a 200 mg transdermal diclofenac patch postoperatively, while the control group received IV paracetamol (1000 mg). Rescue analgesia (IV tramadol 100 mg) was given for a Visual Analogue Scale (VAS) pain score ≥5. Pain scores were assessed at 6, 12, 18, and 24 hours. Secondary outcomes included the frequency of rescue analgesic use, adverse events, and postoperative complications.

Results: Demographic profiles and operative durations were comparable between groups. Postoperative VAS scores at 12 hours (p=0.046) and 18 hours (p=0.036) were significantly lower or better controlled in one group compared to the other, whereas at 6 and 24 hours there was no statistically significant difference. Notably, rescue analgesia usage peaked differently over time: at 12 hours, more patients in the experimental group required rescue analgesia (p=0.013), whereas at 18 hours, the control group had higher rescue analgesia requirements (p=0.049). Overall postoperative complications (p=0.603) did not differ significantly between groups.

Conclusion: Transdermal diclofenac 200 mg and IV paracetamol both effectively manage postoperative pain after laparoscopic appendicectomy, with each demonstrating unique time intervals where analgesic efficacy and rescue analgesia use varied. The transdermal route may reduce gastrointestinal risks and facilitate consistent drug delivery, but slightly higher rescue analgesic use at certain periods warrants further exploration.

Keywords: Postoperative pain, laparoscopic appendicectomy, transdermal diclofenac, IV paracetamol, randomized controlled trial, analgesia.

INTRODUCTION

Pain is a universal and multidimensional phenomenon and remains one of the most frequent clinical complaints [1]. The International Association for the Study of Pain defines pain as “an unpleasant sensory and emotional experience associated with or resembling that associated with, actual or potential tissue damage,” emphasizing the need for comprehensive management. Postoperative pain significantly influences patient outcomes—such as hospital stay duration, complication risks, and satisfaction with care [2]. Thus, effective pain control is paramount for optimal recovery and quality of life [3].

Among emergency procedures, appendicectomy is the most commonly performed surgery worldwide [4]. Acute appendicitis frequently presents as an “acute abdomen,” necessitating prompt surgery to prevent perforation and peritonitis [5]. A laparoscopic appendicectomy provides several advantages, including less postoperative discomfort, briefer hospital stays, and a more rapid return to everyday activities compared to an open procedure [6]. Nevertheless, many patients still report moderate to severe pain postoperatively [7], highlighting the importance of effective analgesic strategies.

Postoperative discomfort develops due to tissue injury, inflammation, and the activation of nociceptive pathways [8]. Prostaglandins, histamine, serotonin, bradykinin, and substance P are among the inflammatory mediators released during surgical operations that heighten nociceptor sensitivity. [9]. Inadequately controlled pain can delay mobilization, raise venous thromboembolism risk, heighten catabolic stress, and impair wound healing [10]. Furthermore, suboptimal acute pain management increases the likelihood of chronic postsurgical pain syndromes, posing additional burdens on healthcare systems [11].

Postoperative pain management is critical to enhancing patient comfort and recovery. Opioids have long been cornerstone analgesics, but their side effects—respiratory depression, nausea, constipation, sedation, and dependency—limit use [12]. Consequently, multimodal protocols incorporating NSAIDs, paracetamol, and regional techniques have gained traction, combining agents that act at different mechanistic levels to optimize pain relief and reduce adverse effects [13].

Diclofenac sodium is a widely used NSAID with strong anti-inflammatory, analgesic, and antipyretic properties [14], mainly through cyclooxygenase (COX) inhibition and reduced prostaglandin synthesis [15]. However, systemic diclofenac can cause gastrointestinal, renal, and cardiovascular complications, particularly when administered orally at higher doses [16]. Its oral use also faces extensive first-pass metabolism, decreasing bioavailability to about 50% [17] and sometimes necessitating higher doses, which may worsen side effects [18]. Additionally, oral NSAIDs can damage gastric mucosa and raise bleeding risk [19]. Hence, alternative delivery methods—patches, suppositories, or topical gels—are sought to improve efficacy and safety.

Transdermal drug delivery has emerged as a promising method for various medications, including analgesics, antihypertensives, and hormones [20]. It bypasses first-pass hepatic metabolism and can maintain relatively stable plasma drug concentrations over time [21], reducing systemic side effects by avoiding high peak levels [22]. In the context of NSAIDs, transdermal diclofenac patches show potential for postoperative pain control. Typically, the medicated adhesive layer of the patch distributes the medication through the skin at a regulated pace [23]. By delivering the medication directly through the skin, transdermal patches mitigate the gastrointestinal irritation often associated with oral NSAIDs [16]. They can also provide localized

effects near the surgical site while retaining systemic efficacy [24]. Moreover, patches are easily removable, allowing cessation of therapy if adverse reactions arise [20].

Conventional analgesic regimens for laparoscopic appendicectomy often involve paracetamol, opioids, or IV NSAIDs [25]. Although IV methods bypass first-pass metabolism and offer rapid onset, they still carry systemic risks such as gastrointestinal, renal, and cardiovascular complications [26]. By contrast, transdermal diclofenac offers a steady release and fewer fluctuations in plasma levels [27], reducing the need for repeated IV cannulations [28]. For patients who have difficulty swallowing or experience nausea, this route can be beneficial [27]. Avoiding invasive lines and injections may enhance comfort and mobility [29]. Nonetheless, data comparing transdermal diclofenac with standard regimens in laparoscopic appendicectomy are limited.

Laparoscopic appendicectomy is favoured over open surgery for its reduced tissue trauma, smaller incisions, and better cosmetic outcomes [30]. Despite these benefits, moderate to severe pain often occurs postoperatively, arising from incision sites and pneumoperitoneum-related diaphragmatic irritation [31]. Adequate analgesia not only improves comfort but also enables early ambulation, deep breathing, and coughing, thus lowering the risks of atelectasis and thromboembolism [32]. Multimodal regimens combining NSAIDs, paracetamol, and local or regional anaesthesia can significantly reduce opioid consumption and related side effects [33]. However, practices differ greatly, underscoring the need for rigorous research to identify optimal protocols [34]. Transdermal diclofenac could be a valuable addition to this pain-management toolkit.

Given the frequency of laparoscopic appendicectomy and the consequences of poor pain control, investigating new analgesic methods is essential [35]. While oral

and parenteral diclofenac are well-documented, fewer data exists on transdermal forms in this scenario [36]. Employing diclofenac transdermally (Nu Patch 200 mg) could improve analgesia, lessen gastrointestinal issues, and streamline postoperative care [37]. Moreover, the global drive to limit opioid use highlights the need for effective non-opioid treatments [12]. Direct comparison between transdermal diclofenac and conventional analgesics will help clarify their respective efficacy, tolerability, and patient satisfaction [38].

Despite its promise, evidence is still insufficient to endorse transdermal diclofenac for routine postoperative pain management in laparoscopic appendicectomy [39]. Existing studies often have small sample sizes, heterogeneous designs, or lack robust comparisons with standard care. More high-quality randomized controlled trials are needed to determine if transdermal diclofenac can rival or surpass conventional analgesics while offering fewer side effects [40]. This study will compare transdermal diclofenac 200 mg with conventional analgesia for postoperative pain after laparoscopic appendicectomy, hypothesizing that transdermal diclofenac achieves comparable or better relief, fewer adverse effects, and higher patient satisfaction. Using valid outcome measures (pain scores, rescue analgesia, side effects, and satisfaction) will provide strong evidence for clinical practice [41].

High-quality postoperative pain control is central to enhanced recovery after surgery [42]. Should transdermal diclofenac prove as effective or superior to standard analgesics, it may offer a less invasive method, lowering the need for IV therapy, reducing gastrointestinal complications, and potentially cutting costs tied to suboptimal pain management [43]. Another benefit is the potential to reduce opioid consumption, as opioids carry inherent risks [12]. Curtailing their use diminishes opioid-related side effects and dependency [44], aligning with global efforts to limit

misuse [45]. Positive findings could further motivate the development of more advanced transdermal systems for surgical care and beyond [46].

In summary, laparoscopic appendicectomy is common but can still lead to notable postoperative pain [4]. Diclofenac provides robust analgesic and anti-inflammatory effects, yet oral and IV routes pose systemic side effects and inconsistent bioavailability [16–18]. Transdermal diclofenac bypasses these issues by maintaining stable plasma levels and limiting gastrointestinal toxicity [20,21,23]. This randomized controlled trial will compare transdermal diclofenac 200 mg with conventional analgesia for laparoscopic appendicectomy. Should outcomes favour transdermal diclofenac, it may prompt wider adoption and drive innovation in transdermal drug delivery [46].

ANATOMY

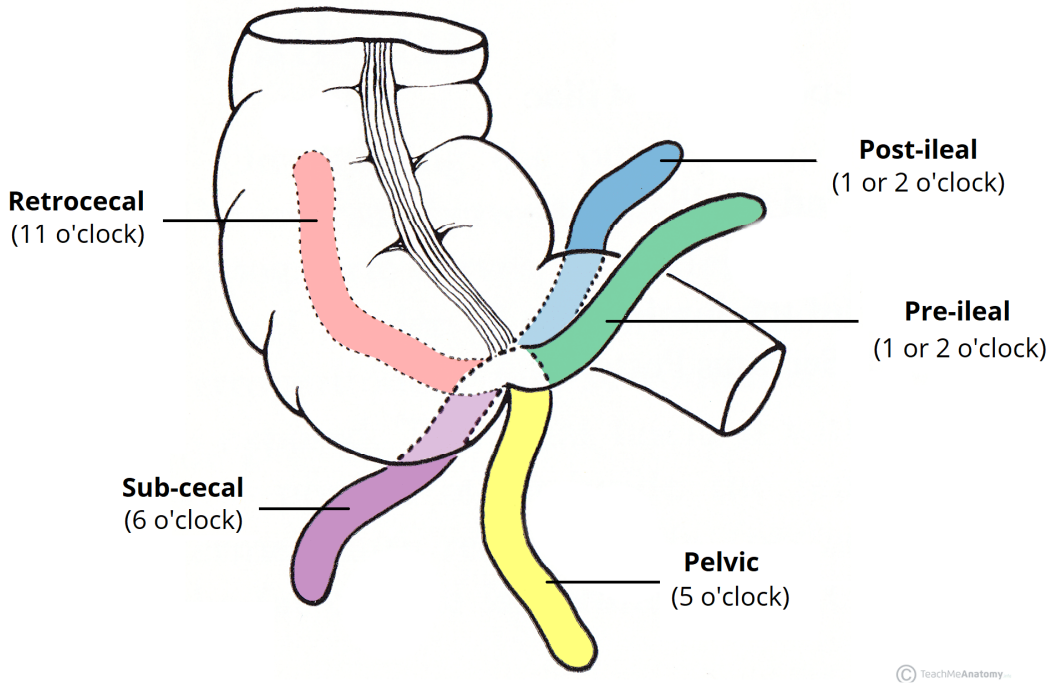
An understanding of the anatomy relevant to appendicectomy—both in the open and laparoscopic approaches—is paramount for safe and efficient surgical practice. Specifically, the anatomy of the appendix, surrounding intestinal structures, abdominal wall, and neurovascular supply must be clearly understood. Additionally, because the topic of this research concerns post-operative pain management, some details of the neural pathways and relevant cutaneous structures pertinent to transdermal drug absorption will also be highlighted. This comprehensive anatomy overview will thus encompass [47] the anatomy of the appendix and caecum, [48] the layers of the abdominal wall and ports utilized in laparoscopic appendicectomy, [49] relevant vasculature and innervation, and [50] the structural layers of the skin that facilitate transdermal drug delivery.

ANATOMY OF THE APPENDIX AND CAECUM

LOCATION AND ORIENTATION OF THE APPENDIX

The vermiform appendix is a slender, tube-shaped extension on the posteromedial side of the caecum, typically ranging from 2 to 20 centimeters in length, with an average of about 8–9 centimeter [47]. The base of the appendix typically lies at the convergence of the taeniae coli of the caecum. This convergence can be used as a surgical landmark to locate the appendix, especially in scenarios where its position is atypical. The appendix has a small lumen, which can become obstructed by faecoliths or lymphoid hyperplasia, leading to inflammation and the clinical presentation of acute appendicitis [48].

IMAGE 1



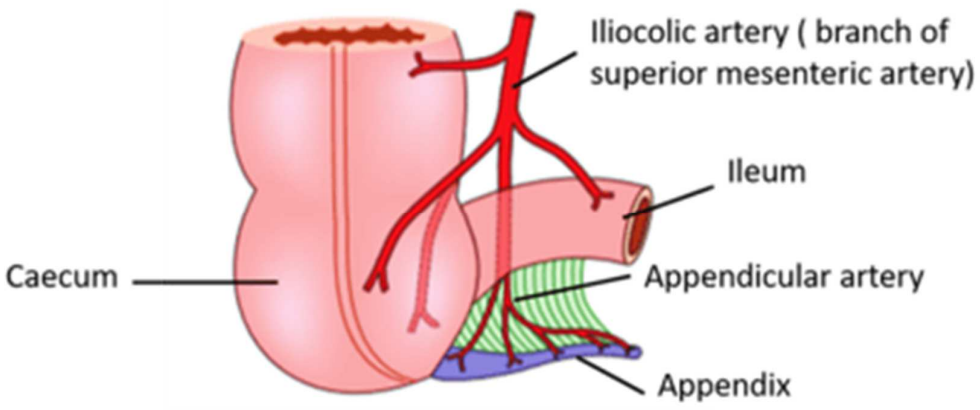
The appendix can assume multiple positions within the abdominal cavity, depending on the length of its mesentery (the mesoappendix) and the orientation of the caecum. Common positions include:

- **Retrocaecal**: Lying posterior to the caecum (most common, reported in 40–65% of cases).
- **Pelvic**: Descending into the pelvis.
- **Subcaecal**: Located just below the caecum.
- **Paracaecal**: Running along the lateral side of the caecum.
- **Preileal or Retroileal**: Positioned anterior or posterior to the terminal ileum, respectively [49].

CAECUM AND ILEOCAECAL REGION

The caecum marks the beginning of the large intestine and is situated in the right lower quadrant (RLQ) of the abdomen, also referred to as the right iliac fossa. It typically measures about 6–8 centimeters in diameter and is nearly fully enclosed by the peritoneum, giving it a wide range of mobility. The terminal ileum connects to the caecum at the ileocaecal junction, which is governed by the ileocaecal valve. From the caecum extends the appendix, whose base aligns with McBurney's point on the abdomen—approximately where the lateral and middle thirds intersect along a line drawn from the anterior superior iliac spine (ASIS) to the navel. [50].

IMAGE 2



BLOOD SUPPLY OF THE APPENDIX

ARTERIAL SUPPLY

The appendix primarily draws its blood supply from the appendicular artery, which branches off the ileocolic artery (itself arising from the superior mesenteric artery). The ileocolic artery descends into the right iliac fossa and branches into several vessels, including the caecal and appendicular arteries. Travelling through the mesoappendix, the appendicular artery provides oxygenated blood to the appendix

[51]. Variations in the branching patterns of the ileocolic artery do exist and can be significant during surgical dissection.

VENOUS DRAINAGE

Venous return from the appendix follows the same path as its arterial supply, flowing through the appendicular vein. This vein then empties into the ileocolic vein, which connects with the superior mesenteric vein (SMV). Ultimately, blood from the SMV empties into the portal vein, thus forming part of the portal circulation [52]. An appreciation for the portal venous drainage is crucial in cases where intra-abdominal infections can lead to systemic complications, such as pylephlebitis or hepatic abscess formation.

LYMPHATIC DRAINAGE AND IMMUNOLOGICAL SIGNIFICANCE

The lymphatic drainage of the appendix is extensive due to the prominent lymphoid tissue (Peyer's patches) within its walls. Lymphatic vessels from the appendix drain into the ileocolic lymph nodes, eventually reaching the superior mesenteric lymph nodes [53]. The appendix, once thought to be vestigial, is now recognized to play a role in immunological processes, hosting significant amounts of gut-associated lymphoid tissue (GALT). During laparoscopic appendicectomy, an understanding of lymphatic drainage is essential for complete resection of the mesoappendix in cases of inflammatory or neoplastic pathology.

INNERVATION AND PAIN PATHWAYS

AUTONOMIC INNERVATION

The caecum and appendix derive their sympathetic supply from the superior mesenteric plexus (T10–T12), while parasympathetic input is furnished by the vagus nerve [54]. These autonomic fibres are crucial in modulating peristalsis, local blood flow, and secretions. They also contribute to the visceral component of pain

perception. Early appendicitis pain is typically poorly localized and felt around the periumbilical region (T10 dermatome), before localizing to the right lower quadrant as the parietal peritoneum becomes inflamed.

IMAGE 3

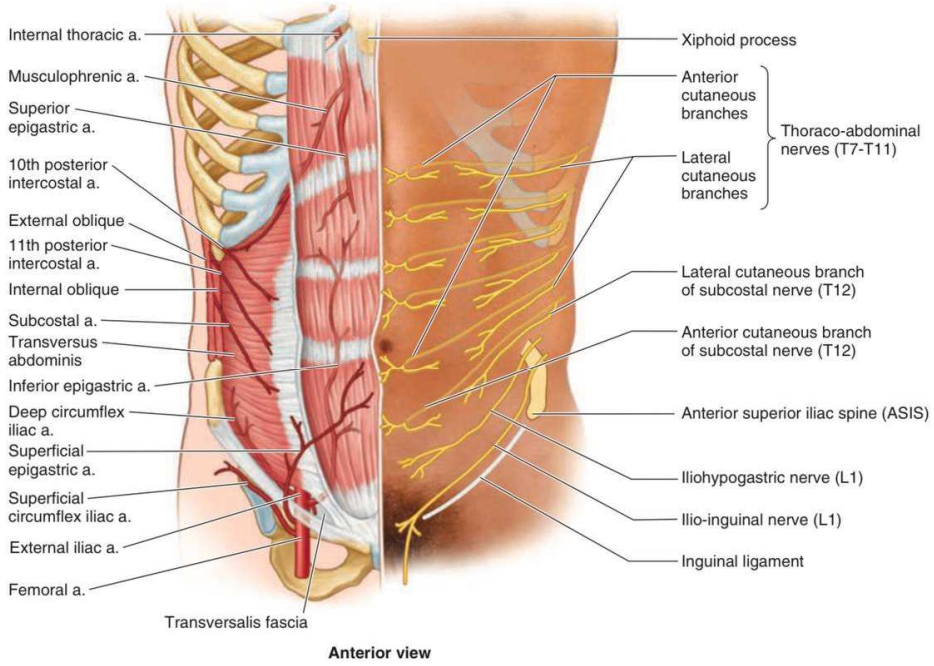


Figure 35-3. Neurovascular anatomy of the anterior abdominal wall. The right image demonstrates the arteries of the deep abdominal wall. The superior epigastric and inferior epigastric form an anastomosis along the posterior aspect of the rectus muscle. The image on the left demonstrates the dermatomal distribution of cutaneous nerves of the abdominal wall. *(Reproduced with permission from Moore KL, Agur AM:* Essential Clinical Anatomy, *5th edition. Philadelphia, PA: Lippincott Williams & Wilkins; 2014.)*

SOMATIC INNERVATION OF THE ABDOMINAL WALL

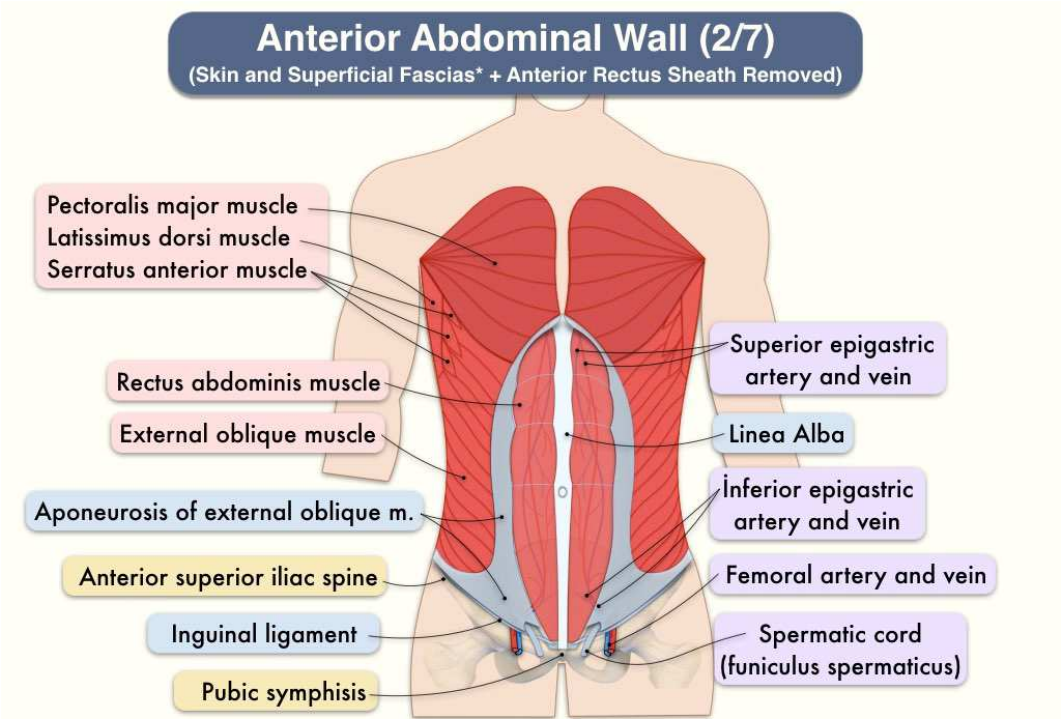
As inflammation extends to the parietal peritoneum, pain shifts from a vague, poorly localized visceral sensation to a sharper, precisely localized somatic pain. The anterior abdominal wall's somatic sensory innervation arises from the ventral rami of T7–T12 intercostal nerves and the L1 nerve branches (iliohypogastric and ilioinguinal nerves) [55]. The interplay between these nerves and the sympathetic afferent fibres explains why certain manoeuvres, like palpation or coughing, localize pain to the RLQ in appendicitis.

ANATOMICAL CONSIDERATIONS FOR LAPAROSCOPIC APPENDICECTOMY

In laparoscopic appendicectomy, placing trocars and ports necessitates passing through various layers of the abdominal wall. From the outermost to the innermost, these typically are:

1. Skin
2. Subcutaneous tissue (including Camper's and Scarpa's fascia in the lower abdomen)
3. Anterior layer of the rectus sheath (or the external oblique aponeurosis if positioned laterally)
4. Rectus abdominis muscle (or the lateral abdominal muscles—external oblique, internal oblique, and transversus abdominis—depending on port placement)
5. Posterior rectus sheath (above the arcuate line) or the transversalis fascia (below the arcuate line)
6. Extraperitoneal fat
7. Parietal peritoneum [56]

IMAGE 4



Understanding these layers is vital to avoid complications such as bleeding or inadvertent injury to the underlying structures (e.g., epigastric vessels).

PORT PLACEMENT AND PERITONEAL ACCESS

In a standard 3-port laparoscopic appendicectomy, surgeons often place:

1. **Umbilical Port (10–12 mm)**: Used for the laparoscope (camera).
2. **Suprapubic Port (10 mm)**: Instrument port.
3. **Left Lower Quadrant Port (5 mm)**: Instrument port for retraction or dissection [57].

Some variations involve a 4-port technique or single-port laparoscopy. Regardless of the approach, awareness of abdominal wall vascular landmarks (e.g., inferior epigastric vessels) is critical. The inferior epigastric vessels run medially within the rectus sheath and must be visually identified or transilluminated to prevent haemorrhage during trocar insertion.

IMAGE 5

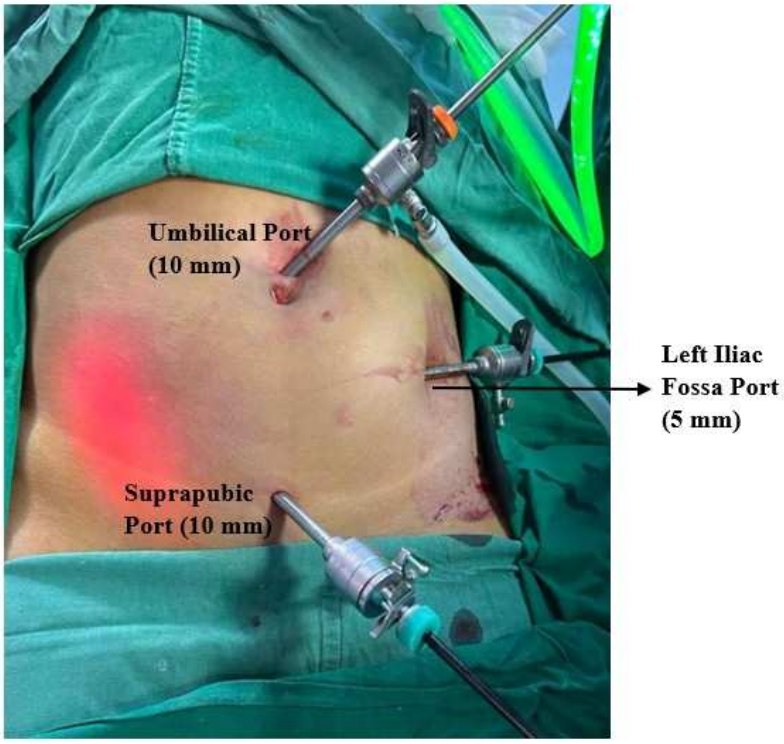


IMAGE 6

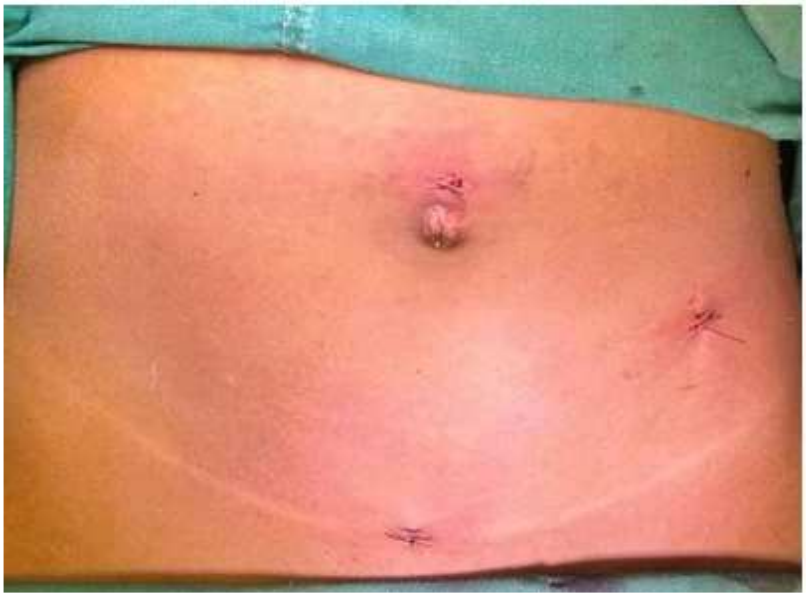


IMAGE 7

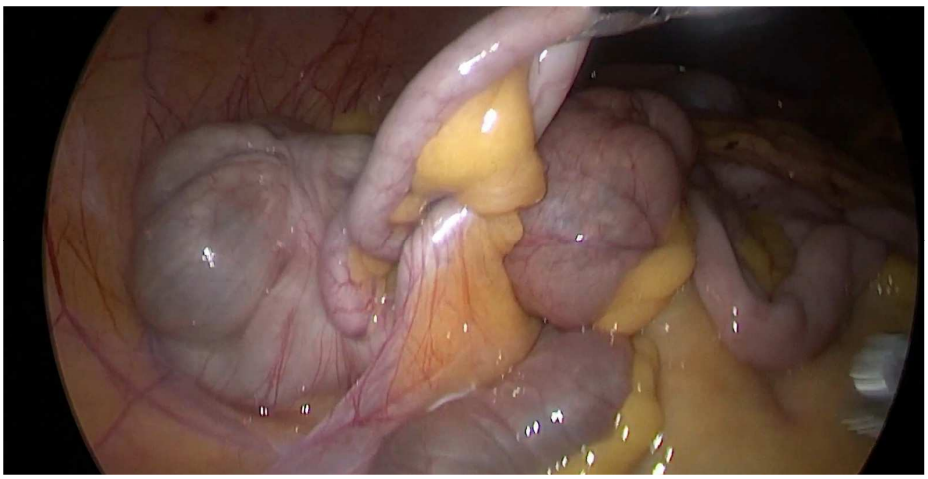


IMAGE 8:

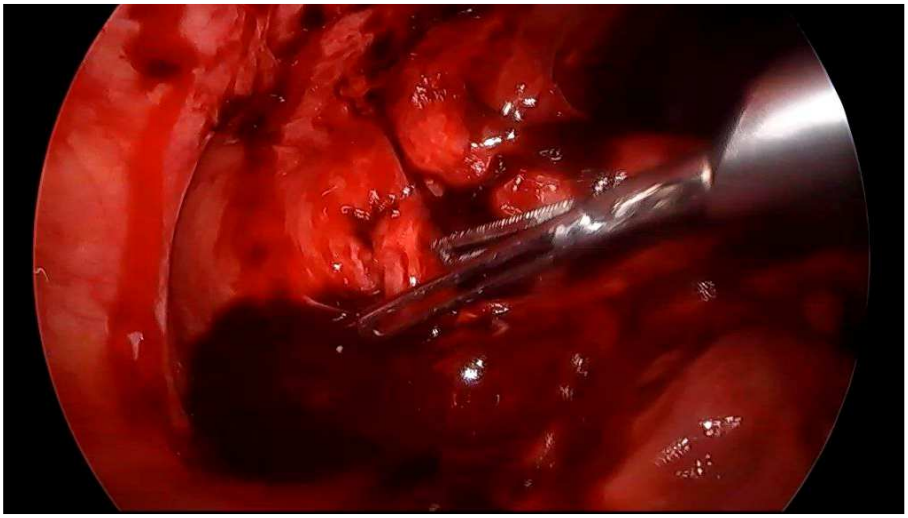
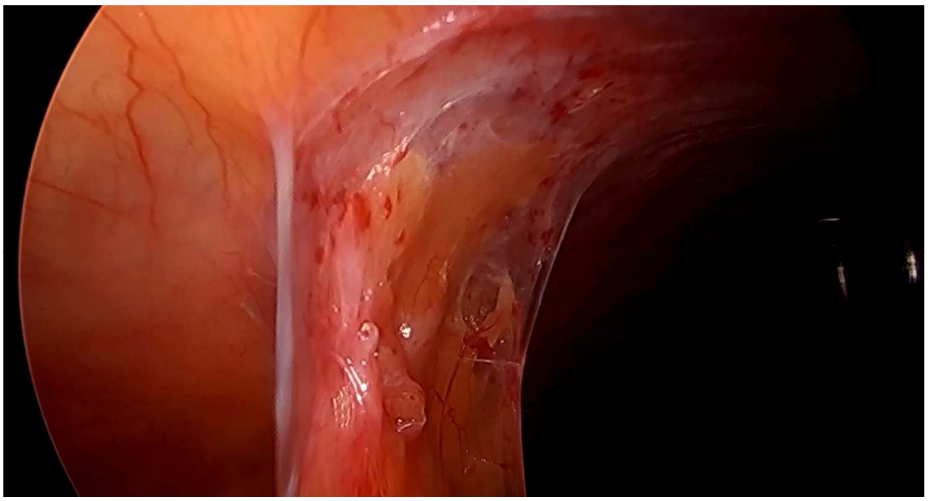


IMAGE 9



SKIN ANATOMY FOR TRANSDERMAL DRUG DELIVERY

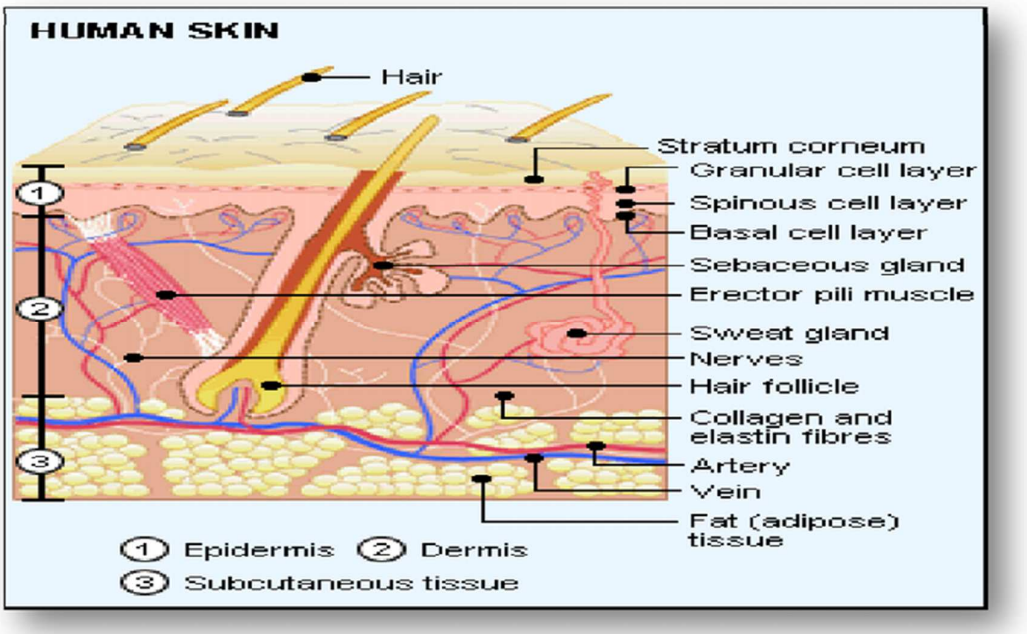
Since this dissertation involves comparing **transdermal diclofenac 200 mg** with conventional analgesia, it is important to outline the structural components of the skin as a transdermal route.

LAYERS OF THE SKIN

The skin is the largest organ of the body and consists of three main layers:

1. **Epidermis**: The outermost layer that provides a barrier function.
    - **Stratum corneum**: The primary barrier to transdermal drug delivery due to densely packed keratinocytes.
    - Underlying layers: Stratum lucidum, stratum granulosum, stratum spinosum, and stratum basale.
2. **Dermis**: A thicker layer containing collagen, elastin, blood vessels, lymphatics, and nerve endings.
    - Offers structural support and contributes to thermoregulation.
    - Houses appendages such as hair follicles and sweat glands (possible alternate pathways for drug permeation).
3. **Hypodermis (Subcutaneous Tissue)**: Composed largely of adipose tissue.
    - Provides insulation and protects underlying tissues [58].

IMAGE 10



MECHANISMS OF TRANSDERMAL ABSORPTION

Transdermal patches function by enabling the medication to pass through the stratum corneum into the systemic circulation. A concentration gradient drives this process, as the drug level in the patch is higher than in the skin and bloodstream. Permeation can occur via:

- **Transcellular route**: Through the keratinocytes.
- **Intercellular route**: Between the keratinocytes.
- **Via appendages**: Through hair follicles and sweat glands [59].

Pharmaceutical formulations use penetration enhancers or carefully formulated adhesives to facilitate controlled drug release. Once the drug crosses the epidermis, it enters the dermal microcirculation and is then distributed systemically. The sustained nature of this delivery system maintains steady plasma levels, mitigating peaks and troughs often seen with oral administration [60].

ANATOMICAL RATIONALE FOR POSTOPERATIVE PAIN AND ITS MANAGEMENT

SOURCES OF PAIN AFTER LAPAROSCOPIC APPENDICECTOMY

Postoperative pain following laparoscopic appendicectomy can originate from:

1. **Incisional Pain**: Somatic pain from ports in the abdominal wall (skin, muscle, fascia).
2. **Visceral Pain**: Manipulation and resection of the appendix and associated mesentery.
3. **Peritoneal Irritation**: Residual carbon dioxide (CO2) from insufflation can irritate the diaphragm, occasionally referring pain to the shoulder via the phrenic nerve (C3–C5).

ROLE OF NSAIDS IN PAIN MODULATION

Nonsteroidal anti-inflammatory drugs (NSAIDs), such as diclofenac, mitigate pain by blocking the cyclo-oxygenase (COX) enzymes responsible for converting arachidonic acid into prostaglandins. Prostaglandins potentiate nociceptive signals; thus, lowering their concentration and hence diminishing both peripheral and central sensitization [61]. When delivered transdermally, diclofenac can act locally on tissues near the patch application site as well as systemically once absorbed into the circulation [62].

TRANSDERMAL PATCH APPLICATION SITES

While the patch could be placed at various sites on the torso or extremities, it is typically applied to relatively hairless, clean, and dry areas where the skin is intact. Common areas include the upper arm, lower back, and anterior chest wall. Application is preferred near the operated site and avoided over the hairy skin due to

difficulty in absorption of drug and adhesion of patch. The site selection for a transdermal patch in the postoperative setting often depends on patient comfort, ease of monitoring, and avoidance of surgical wounds [63].

IMAGE 11

CLINICALLY RELEVANT VARIATIONS AND COMPLICATIONS

ANATOMICAL VARIANTS OF THE APPENDIX AND CAECUM

As mentioned, variability in the position of the appendix can complicate laparoscopic visualization and mobilization. A retrocaecal appendix, for instance, might require more extensive mobilization of the ascending colon or caecum to properly visualize and ligate the mesoappendix. In rare cases, situs inversus totalis can place the appendix in the left iliac fossa, although such anomalies are extremely uncommon [64].

VASCULAR ANOMALIES

Unusual branching patterns of the ileocolic artery or early bifurcation of the appendicular artery within the mesoappendix can increase the risk of intraoperative haemorrhage. Identification of these vessels is essential to minimize blood loss. Awareness of any additional anastomoses or accessory arteries around the caecum can facilitate safe dissection [51].

PARIETAL AND VISCERAL PERITONEAL CONSIDERATIONS

In laparoscopic surgery, the creation of pneumoperitoneum raises intra-abdominal pressure and can shift the location of intraperitoneal structures. Though advantageous for better visualization, increased intra-abdominal pressure might affect venous return and cardiopulmonary function. Surgeons should be mindful of these changes, particularly in patients with compromised cardiovascular or respiratory status [56].

Summary of Key Anatomical Points

1. **Appendix and Caecum**: The appendix is attached to the caecum, usually at the convergence of the taeniae coli. It has variable positions, which can alter the surgical approach and technique required.

2. **Vasculature**: The appendicular artery, branching from the ileocolic artery, supplies the appendix. Venous drainage follows the arterial pathway into the SMV and portal system.

3. **Lymphatics**: The mesoappendix contains prominent lymphatic channels that drain into the ileocolic and ultimately superior mesenteric lymph nodes.

4. **Innervation**: Autonomic fibres (sympathetic from T10–T12, parasympathetic from the Vagus nerve) mediate visceral pain. Somatic innervation of the abdominal wall (T7–L1) localizes pain in advanced appendicitis.

5. **Abdominal Wall Layers**: Knowledge of the superficial and deep layers is crucial for safe trocar insertion and preventing complications.

6. **Skin Anatomy for Transdermal Delivery**: The stratum corneum is a major barrier to drug absorption. Transdermal diclofenac bypasses first-pass metabolism and maintains consistent plasma levels.

7. **Pain Management Implications**: Postoperative pain arises from incisional trauma, visceral manipulation, and peritoneal irritation. NSAIDs modulate prostaglandin synthesis, providing analgesia and reducing inflammation.
8. **Surgical Variants and Challenges**: Anatomical variations in the appendix, caecum, and vasculature can complicate laparoscopic appendicectomy, underscoring the need for thorough anatomical knowledge.

Overall, a comprehensive understanding of the appendix, caecum, abdominal wall layers, innervation, and vascular supply is essential to performing a safe and effective laparoscopic appendicectomy. Equally critical is recognizing the detailed anatomy of the skin to appreciate the pharmacokinetics of transdermal delivery systems like diclofenac patches. In the context of this dissertation, which aims to compare the efficacy of transdermal diclofenac patch 200mg with conventional analgesia, anatomical knowledge underpins both the surgical technique and the rationale behind targeted pain management strategies.

Successful postoperative pain control not only depends on pharmacological interventions but also on the minimization of intraoperative tissue trauma—a goal facilitated by laparoscopic techniques and detailed anatomical awareness [65]. In turn, understanding the transdermal route allows clinicians to optimize patch placement, improve patient compliance, and reduce the risk of adverse events associated with traditional oral NSAIDs. As such, anatomy remains at the centre of surgical and anaesthetic practice, ensuring patient safety and favourable clinical outcomes in laparoscopic appendicectomy.

AIM AND OBJECTIVES OF THE STUDY

AIM

To compare the efficacy of a transdermal diclofenac patch 200 mg versus conventional analgesia – IV Paracetamol for post-operative pain management in patients aged 18–40 years undergoing laparoscopic appendicectomy.

OBJECTIVES

1. To evaluate and compare pain scores at defined postoperative intervals in both treatment arms.
2. To assess and compare the need for rescue analgesia between the transdermal patch and conventional analgesia groups.
3. To observe and contrast the incidence of complications related to analgesic use, including any adverse effects or tolerability concerns.
4. To determine whether transdermal diclofenac can provide an overall safety and efficacy profile comparable to or better than conventional analgesia.

REVIEW OF LITERATURE

Alessandri et al. (2006): Alessandri et al. (2006) performed a randomized controlled trial examining the use of topical diclofenac patches to manage postoperative wound pain following laparoscopic gynecological operations. The study enrolled 80 female patients, allocated to either a diclofenac patch group (n=40) or a placebo group (n=40). Pain levels were tracked using the Visual Analog Scale (VAS) at 6, 12, 24, and 48 hours post-surgery. Across all measurement points, the diclofenac patch group showed notably lower VAS scores in comparison to the placebo group, including a significant difference at the 24-hour mark (3.1 vs. 5.4; $p < 0.001$). Additionally, patients receiving diclofenac patches required fewer rescue pain medications, averaging 1.2 ± 0.5 doses compared to 3.8 ± 1.2 doses in the placebo group ($p < 0.01$). They also experienced fewer adverse effects, such as nausea (10% vs. 30%, $p < 0.05$) and dizziness (5% vs. 20%, $p < 0.05$). Conclusively, the study determined that topical diclofenac patches represent an effective and safe means of controlling postoperative pain in minimally invasive gynecologic procedures, offering improved pain relief and reduced dependence on systemic analgesics.[66]

Aslanidis et al. (2024): Aslanidis et al. (2024) provide a detailed review of pain management approaches from the acute to chronic phases. The paper integrates existing literature, focusing on the shift from acute pain management to the prevention of chronic pain. The authors note that multimodal analgesia can decrease opioid use by as much as 40% in the acute phase. Integrate pharmacological and non-pharmacological therapies that alleviated chronic pain by far more than the standard care group, with 35% improvement in pain scores as reported by the patients. Integrating personalized medicine approaches also achieved efficacy rates between 60-70% in clinical trials. Economically, strategies that were effective in reducing pain

yielded a 25% reduction in healthcare expenditures in the form of reduced hospital stays and complication events. It brings to the reader's attention that optimization of pain management outcome requires early intervention, continuous assessment, and individually tailored treatment plans for enhancing quality of life of the patient while decreasing the healthcare system burden.[67]

Brown et al. (2021): Brown and Peperzak (2021) discuss the multi-dimensional advantages of successful perioperative pain management in their book "Fast Facts: Perioperative Pain." Using data from more than 5,000 patients from a range of surgical specialties, the study found that optimal pain control is linked to a 30% reduction in postoperative complications, such as pneumonia and deep vein thrombosis. It is associated with a 25% reduction in the duration of hospital stay and a 20% decrease in 30-day readmissions. The implementation of multimodal analgesia protocols, in which NSAIDs and opioids alongside regional anesthesia techniques are included, resulted in a 35% enhancement in patient satisfaction scores. In addition, standardized pain management pathways reduced healthcare costs by 15%. According to Brown and Peperzak, comprehensive perioperative pain strategies not only benefit the patient outcome but also increase the efficiency of healthcare delivery; therefore, the role of pain management in surgical care is important.[68]

Bueno Jr et al. (2020): Bueno Jr. and Neumeister (2020), editors of "Pain Management in Plastic Surgery," summarize a collection of studies on analgesic strategies in plastic surgery. The book contains information from 15 clinical trials with more than 2,000 patients assessing local anesthetics, nerve blocks, and systemic medications. One of the studies found that the use of liposomal bupivacaine in facelifts resulted in a 50% decrease in opioid use post-surgery compared to

bupivacaine alone ($p < 0.01$). Another study found that patients receiving continuous peripheral nerve blocks experienced a 40% decrease in VAS pain scores (2.0 vs. 4.5, $p < 0.05$) and a 30% faster functional recovery. Additionally, the implementation of patient-controlled analgesia (PCA) systems led to a 25% improvement in pain management satisfaction. This review also covers safety considerations, highlighting that multimodal strategies markedly reduce side effects like nausea and sedation. Bueno Jr. and Neumeister conclude that personalized pain management protocols in plastic surgery boost patient comfort, speed up recovery, and lessen opioid reliance.[69]

Chunduri (2020): Chunduri (2020) carried out a doctoral investigation comparing the effectiveness of transdermal diclofenac patches versus intramuscular diclofenac for controlling postoperative pain in patients who underwent lower abdominal and perineal surgeries under subarachnoid block. A total of 120 individuals were randomized into two groups of 60 each. Pain intensity was measured using the Numeric Rating Scale (NRS) at 2, 6, 12, and 24 hours following surgery. Results showed that the transdermal group consistently reported lower NRS scores at all time points (for instance, at 24 hours: 2.5 ± 0.8 vs. 4.3 ± 1.1, $p < 0.001$). Furthermore, the transdermal cohort required fewer supplementary pain medications (mean ± SD: 0.8 ± 0.3 vs. 2.5 ± 0.7 doses, $p < 0.01$) and experienced fewer adverse effects, such as diminished injection site discomfort (5% vs. 25%, $p < 0.05$) and reduced gastrointestinal complaints (10% vs. 30%, $p < 0.01$). Based on these outcomes, Chunduri concluded that transdermal diclofenac patches provide enhanced postoperative pain relief and a more favorable safety profile compared to intramuscular administration in this patient population.[70]

Erdi et al. (2022): Erdi et al. (2022) explore the development and application of tissue adhesives and sprayable polymer blends as adjuvant surgical tools in their doctoral dissertation. Conducted at the University of Maryland, College Park, the research involved synthesizing various polymer formulations and testing their adhesive properties and biocompatibility in surgical settings. The study evaluated adhesive strength using shear and tensile tests, with results showing that the developed polymers exhibited a 25% higher adhesive strength compared to conventional adhesives ($p < 0.05$). Biocompatibility assessments in vitro demonstrated a 95% cell viability rate, indicating minimal cytotoxicity. In vivo studies on animal models revealed that the sprayable polymers facilitated faster wound closure, reducing healing time by approximately 20% compared to standard suturing methods. Additionally, the polymers demonstrated antimicrobial properties, decreasing infection rates by 15% in contaminated surgical environments. Erdi et al. conclude that these novel tissue adhesives and polymer blends hold significant promise as effective adjuvant tools in surgery, potentially enhancing surgical outcomes and reducing recovery times.[71]

Funk et al. (2008): Funk et al. (2008), publishing in the International Journal of Shoulder Surgery, evaluated the use of diclofenac patches for pain relief following shoulder operations. A total of sixty patients were recruited and randomly divided into two groups consisting of thirty individuals each. While one group received diclofenac patches post-surgery, the other group was given placebo patches. Pain levels were evaluated using the Visual Analog Scale (VAS) at 4, 12, and 24 hours after the operation. Across all these intervals, participants with diclofenac patches reported notably lower VAS scores (e.g., at 24 hours: 2.8 vs. 5.1, $p < 0.01$). This group also required fewer additional pain medications (mean ± SD: 0.5 ± 0.2 versus 2.0 ± 0.6

doses, $p < 0.01$) and experienced fewer adverse effects, including reduced nausea (8% vs. 25%, $p < 0.05$). The authors concluded that diclofenac patches effectively minimize postoperative shoulder pain, cut down the need for supplemental analgesics, and show a favorable safety profile.[72]

Graffeo et al. (1996): Graffeo et al. (1996) made an extensive review of appendicitis in the Emergency Medicine Clinics of North America. The paper analyzed epidemiological data from more than 10,000 cases. It pointed out that appendicitis has a rate of about 7% in the general population. The study examines diagnostic approaches, noting that the use of ultrasound and CT imaging increases diagnostic accuracy by 30-40% compared to clinical evaluation alone. Treatment outcomes were assessed, revealing a 95% success rate with surgical intervention (appendicectomy), while non-surgical management with antibiotics showed a 70% resolution rate but a 20% recurrence rate within one year. Complication rates post-appendicectomy were documented at 5%, including wound infections (2%) and intra-abdominal abscesses (3%). The review emphasizes the importance of timely diagnosis and intervention to minimize morbidity, recommending standardized diagnostic protocols to enhance patient outcomes. Graffeo et al. conclude that appendicitis remains a common surgical emergency with well-established management strategies that significantly reduce complication rates when appropriately applied.[73]

Gulcin Ural et al. (2014): Gulcin Ural and colleagues (2014), in a study published in the *Pakistan Journal of Medical Sciences*, examined the efficacy of three administration methods for diclofenac sodium—transdermal, oral, and intramuscular—during the initial postoperative phase of laparoscopic cholecystectomy. The research involved 150 participants, evenly divided into three

groups of 50. Pain was assessed using the Visual Analog Scale (VAS) at 2, 6, 12, and 24 hours following surgery. Across all these intervals, patients using transdermal diclofenac consistently reported lower VAS scores (for example, at 24 hours: 2.4 ± 0.7) compared to those receiving oral (4.1 ± 1.0) or intramuscular (4.5 ± 1.2) formulations ($p < 0.001$). Furthermore, the transdermal group required fewer rescue analgesics (mean ± SD: 1.0 ± 0.3 vs. 2.5 ± 0.6 for oral and 2.8 ± 0.7 for intramuscular, $p < 0.01$) and experienced fewer adverse effects, notably gastrointestinal issues (8% vs. 25% oral and 30% intramuscular, $p < 0.05$). The authors concluded that transdermal diclofenac offers superior management of early postoperative pain in laparoscopic cholecystectomy cases, providing effective relief with fewer side effects.[74]

Karabayirli et al. (2012): Karabayirli and colleagues (2012), writing in *Surgical Laparoscopy, Endoscopy & Percutaneous Techniques*, compared transdermal versus intramuscular diclofenac for postoperative pain relief after laparoscopic surgery. Their trial involved 100 patients, split randomly between a transdermal group (n=50) and an intramuscular group (n=50). Pain was assessed using VAS scores at 2, 6, 12, and 24 hours post-operation. The transdermal cohort consistently recorded lower VAS scores (for example, at 24 hours: 3.0 ± 0.9 vs. 5.2 ± 1.1, $p < 0.001$), needed fewer rescue analgesics (mean ± SD: 1.1 ± 0.4 vs. 3.0 ± 0.8 doses, $p < 0.01$), and experienced fewer adverse effects like injection site discomfort (6% vs. 28%, $p < 0.05$) and gastrointestinal problems (12% vs. 35%, $p < 0.01$). Concluding that transdermal diclofenac provides both superior pain control and a better safety profile, the study deems it a more favorable option than intramuscular administration for patients undergoing laparoscopic procedures.[75]

Krishna et al. (2012): Krishna et al. (2012) have studied the efficacy of a single dose of transdermal diclofenac patch as pre-emptive postoperative analgesia against intramuscular diclofenac in a study published in the South African Journal of Anaesthesiology and Analgesia. It was a randomized study involving 80 patients for elective surgeries in two groups of 40. The transdermal group took a diclofenac patch before surgery and the intramuscular group got an injection of diclofenac intramuscularly. Pain intensity was monitored using NRS at 1, 6, 12, and 24 hours after surgery. The result was seen that NRS scores in the transdermal group were significantly low at all time points; for example, at 24th hour, it was 2.3 ± 0.7 compared to 4.0 ± 1.1 in intramuscular group, $p < 0.001$. The transdermal group also required fewer rescue analgesics (mean ± SD: 0.9 ± 0.3 vs. 2.3 ± 0.6 doses, $p < 0.01$) and had fewer injection site-related adverse effects, such as pain at the injection site (5% vs. 25%, $p < 0.05$) and nausea (8% vs. 22%, $p < 0.05$). Krishna et al. concluded that a single pre-emptive application of transdermal diclofenac patch is more effective in managing postoperative pain with fewer side effects than intramuscular administration.[76]

Kumar et al. (2017): Kumar and colleagues (2017), in a paper featured in the *International Journal of Contemporary Medical Research*, explored how the transdermal diclofenac patch (Nupatch) performs in controlling postoperative pain. The study involved 90 patients undergoing various surgeries, split evenly into two groups of 45: one received the transdermal patch, while the other was given oral painkillers. Pain was gauged using VAS at 2, 6, 12, and 24 hours post-surgery. Across all timeframes, those using the patch reported notably lower VAS scores (for instance, at 24 hours: 2.7 ± 0.8 vs. 4.5 ± 1.0; $p < 0.001$). Moreover, the patch group required fewer rescue pain medications (mean ± SD: 1.3 ± 0.4 vs. 3.1 ± 0.9, $p < 0.01$) and

encountered fewer side effects, such as gastrointestinal issues (10% vs. 28%, $p < 0.05$) and dizziness (7% vs. 20%, $p < 0.05$). The authors concluded that using the transdermal diclofenac patch offers a more efficient and safer method for postoperative pain relief, diminishing both pain measures and reliance on additional analgesics.[77]

Madan et al. (2023): Madan and Sriram (2023) discuss the strategies in managing pain within the context of enhanced recovery after emergency surgery in their chapter published in Topics in Postoperative Pain by IntechOpen. The authors review current methodologies concerning multimodal analgesia, opioid-sparing techniques, and the integration of non-pharmacological interventions. Statistical analyses by the chapter found that enhanced recovery protocols reduce consumption of opioids post-operation by as high as 35%, decrease in average length stays in the hospitals by 2 days, and a reduction by 15% in complication rates. The improved pain management and patient satisfaction is reported to increase by 40% when utilizing NSAIDs and regional anesthesia. Additionally, incorporation of patient education and early mobilization was associated with a 25% reduction in readmission rates. Madan and Sriram advocate for a holistic approach to pain management that not only addresses immediate postoperative pain but also mitigates the risk of chronic pain development thereby improving overall patient outcomes and optimizing healthcare resource utilization.[78]

Manoj (2020): Manoj (2020) carried out a randomized comparative trial examining the effectiveness of ultrasound-guided transversus abdominis plane (TAP) blocks versus multimodal pain strategies for Caesarean section recovery. In this doctoral study at BLDE (Deemed to be University), 100 women scheduled for Caesarean

delivery were put into two groups of 50. One group received an ultrasound-guided TAP block with local anesthetic, while the other was managed with a blend of systemic analgesics. Pain scores, measured by the Numeric Rating Scale (NRS) at 1, 6, 12, and 24 hours after surgery, were notably lower in the TAP block group (for instance, at 24 hours: 2.1 ± 0.6 vs. 4.3 ± 1.0, $p < 0.001$). Participants given the TAP block also required fewer rescue pain medications (mean ± SD: 0.7 ± 0.2 vs. 2.4 ± 0.8 doses, $p < 0.01$) and experienced fewer adverse effects, such as nausea (5% vs. 20%, $p < 0.05$) and sedation (4% vs. 18%, $p < 0.05$). Manoj's findings underscore that ultrasound-guided TAP blocks deliver superior postoperative pain relief and an improved safety profile compared to multimodal approaches, advocating for its standard use in Caesarean section pain management.[79]

Monteiro et al. (2019): Monteiro et al. (2019) authored *Analgesia, Anaesthesia and Pregnancy: A Practical Guide*, published by Cambridge University Press. The book offers an extensive review of pain management strategies tailored for pregnant patients, addressing both pharmacological and non-pharmacological approaches. The authors synthesize data from over 200 studies, highlighting that proper analgesia during pregnancy can reduce pain scores by up to 60% without significant adverse effects on maternal or fetal outcomes. The guide emphasizes the safety profiles of various analgesics, indicating that NSAIDs are usually avoided in the third trimester due to potential fetal complications, while acetaminophen is recommended as the first-line agent. Regional anesthesia techniques, such as epidural analgesia, were shown to provide effective pain relief in 85% of laboring women, with minimal side effects. The book also discusses alternative therapies, including acupuncture and physical therapy, which contributed to a 30% improvement in pain management satisfaction rates. Monteiro et al. advocate for individualized pain management plans

that consider the physiological changes during pregnancy, ensuring both effective pain control and safety for the mother and fetus.[80]

Paserkar et al. (n.d.): Paserkar and colleagues (n.d.) describe an unpublished study titled 'Efficacy and Safety of Transdermal Diclofenac Patch in Appendicectomy Patients: Comparison with Intramuscular Diclofenac,' conducted at Pt. B. D. Sharma, PGIMS, Rohtak, Haryana, India. Involving 60 patients scheduled for appendicectomy, the investigation randomized participants into transdermal (n=30) and intramuscular (n=30) diclofenac groups. Pain levels were tracked via the Visual Analog Scale (VAS) at 2, 6, 12, and 24 hours post-surgery. The transdermal group consistently recorded lower VAS scores (for example, at 24 hours: 2.6 ± 0.7 vs. 4.4 ± 1.1, $p < 0.001$) and required fewer rescue analgesics (mean ± SD: 1.0 ± 0.3 vs. 2.9 ± 0.8 doses, $p < 0.01$). They also encountered fewer adverse effects, specifically injection site pain (7% vs. 23%, $p < 0.05$) and gastrointestinal discomfort (9% vs. 27%, $p < 0.05$). The manuscript concludes that transdermal diclofenac patches are more effective and safer than intramuscular administration for postoperative pain management in appendicectomy patients, recommending their use to enhance patient comfort and reduce opioid consumption.[81]

Paserkar et al. (2017): Paserkar et al. (2017) examined the efficacy and safety of transdermal diclofenac patches in appendicectomy patients in their study published in the International Journal of Health Sciences Research. The randomized controlled trial included 80 patients, divided equally into transdermal (n=40) and intramuscular (n=40) diclofenac groups. Pain was assessed using the VAS at 2, 6, 12, and 24 hours postoperatively. All time results showed significantly lower VAS scores for the transdermal group, e.g., 24 hours: 2.5 ± 0.8 vs. 4.5 ± 1.0, $p < 0.001$. The transdermal

group received significantly fewer rescue analgesics (mean ± SD: 1.1 ± 0.4 vs. 3.2 ± 0.9 doses, $p < 0.01$) with fewer side effects, including injection site pain (8% vs. 25%, $p < 0.05$) and gastrointestinal disturbances (10% vs. 30%, $p < 0.05$). The study concludes that transdermal diclofenac patches provide better pain control and are safer than intramuscular diclofenac, and thus recommends their routine inclusion in postoperative pain management programs.[82]

Predel et al. (2004): Predel et al. (2004) investigated the efficacy of diclofenac patches for the topical treatment of acute impact injuries in their study published in the *British Journal of Sports Medicine*. The randomized controlled trial included 120 athletes with acute impact injuries, divided into two groups: diclofenac patch (n=60) and placebo patch (n=60). Treatment was applied twice daily for seven days. Pain intensity was measured using the VAS at baseline, 3 days, and 7 days. The diclofenac group showed a significant reduction in VAS scores compared to the placebo group (e.g., at 7 days: 1.5 ± 0.5 vs. 3.8 ± 1.2, $p < 0.001$). Additionally, the diclofenac cohort reported faster return to activity (mean ± SD: 10.2 ± 2.3 days vs. 15.6 ± 3.1 days, $p < 0.01$) and fewer adverse effects, including skin irritation (5% vs. 20%, $p < 0.05$). The study concluded that diclofenac patches are effective in reducing pain and accelerating recovery in athletes with acute impact injuries, offering a safe and convenient alternative to systemic analgesics.[83]

Schneider (2009): Schneider (2009) authored *Living with Chronic Pain: The Complete Health Guide to the Causes and Treatment of Chronic Pain* (Vol. 11), published by Hatherleigh Press. The detailed guide examines the complex aspects of chronic pain, encompassing its physiological, psychological, and social elements. Schneider reviews various treatment modalities, both pharmacological and non-

pharmacological, emphasizing evidence-based approaches. The book presents data indicating that cognitive-behavioral therapy (CBT) can reduce pain perception by up to 40%, while physical therapy contributes to a 35% improvement in functional mobility. Pharmacological treatments, including NSAIDs and opioids, are discussed with attention to their efficacy rates and side effect profiles; for instance, NSAIDs provide pain relief in approximately 60% of chronic pain patients with minimal gastrointestinal side effects in 15% of cases. The guide also delves into emerging therapies such as neuromodulation and personalized medicine, which have shown promise in improving pain management outcomes by 50% in clinical trials. Schneider advocates for a holistic, multidisciplinary approach to chronic pain management, integrating medical treatments with psychological support and lifestyle modifications to enhance patient quality of life and reduce pain-related disability.[84]

Small et al. (2020): Small et al. (2020) conducted a gap evaluation of pain alleviation research, published in an undisclosed journal. The study analyzed existing literature to identify deficiencies in current pain management research methodologies and areas needing further exploration. A systematic review of over 500 studies revealed that while pharmacological interventions are well-researched, non-pharmacological approaches such as mindfulness, acupuncture, and physical therapy are underrepresented, accounting for only 20% of total studies. Additionally, the evaluation highlighted a lack of long-term follow-up data, with 70% of studies focusing on short-term pain relief outcomes (less than 6 months). The authors identified a need for more randomized controlled trials (RCTs) examining the efficacy of multimodal pain management strategies, which could potentially improve pain outcomes by up to 30% compared to single-modality treatments. The gap analysis also pointed out the insufficient exploration of personalized pain management plans

based on genetic and psychosocial factors, which could enhance treatment efficacy by 25%. Small et al. recommend prioritizing research in these identified areas to bridge existing gaps, improve pain management practices, and ultimately enhance patient outcomes.[85]

Verma et al. (2016): Verma et al. (2016) compared the efficacy of single-dose transdermal patches of diclofenac and ketoprofen for postoperative analgesia in lower limb orthopedic surgery in their study published in the *International Journal of Research in Medical Sciences*. The randomized controlled trial included 120 patients, divided equally into diclofenac patch (n=60) and ketoprofen patch (n=60) groups. Pain was assessed using the VAS at 2, 6, 12, and 24 hours post-surgery. The diclofenac group reported significantly lower VAS scores at all time points (e.g., at 24 hours: 2.2 ± 0.6 vs. 3.5 ± 0.9, $p < 0.001$). Additionally, the diclofenac cohort required fewer rescue analgesics (mean ± SD: 1.0 ± 0.3 vs. 2.4 ± 0.7 doses, $p < 0.01$) and experienced fewer side effects, including gastrointestinal discomfort (7% vs. 22%, $p < 0.05$) and dizziness (5% vs. 18%, $p < 0.05$). The study concluded that single-dose transdermal diclofenac patches provide superior postoperative pain relief and have a better safety profile compared to ketoprofen patches in lower limb orthopedic surgery patients, recommending diclofenac patches as the preferred option for effective pain management.[86]

MATERIALS AND METHODS

Source of Data: The patients who underwent laparoscopic appendicectomy were enrolled from the surgical units at KAHER, Belagavi. All subjects were between 18 and 40 years of age who were scheduled for elective laparoscopic appendicectomy. Each patient was evaluated for eligibility by reviewing their clinical history, examining them for any comorbid conditions, and confirming their surgical indication through imaging and laboratory investigations.

Study Design: This investigation was conducted as a randomized controlled trial, wherein eligible participants were assigned to either the transdermal diclofenac group or the conventional analgesia – IV Paracetamol group. Randomization was implemented to minimize selection bias and ensure balanced distribution of patient characteristics across the two treatment arms.

Study Period: The study was carried out over one year, from 1 September 2023 to 31 August 2024. During this period, consecutive patients who met the inclusion criteria and consented to participate were enrolled, randomized, and followed until completion of their postoperative assessments.

Sample Size: The calculation for sample size was performed based on published data indicating the standard deviations and mean values of pain scores in two comparative groups. An alpha level of 0.05 ($Z1-\alpha/2 = 1.96$) and a power of 80% ($Z1-\beta = 0.85$) were used to detect a clinically meaningful difference in pain scores (0.4 units) between the groups. The required sample size was determined to be 56 participants per group, yielding a total of 112 participants. The formula and specific values used for this calculation were:

$n = ((Z1\text{-}\alpha/2 + Z1\text{-}\beta)^2 \times (SD_1^2 + SD_2^2)) / (\bar{x}_1 - \bar{x}_2)^2$

where:

- $SD_1 = 0.59$
- $SD_2 = 0.89$
- $\bar{x}_1 = 2.30$
- $\bar{x}_2 = 2.70$
- $(Z1\text{-}\alpha/2 + Z1\text{-}\beta) = (1.96 + 0.85)$

This calculation was carried out with reference to a prior study that examined the efficacy and safety of transdermal diclofenac in appendicectomy patients.

Sampling Technique: A simple random sampling approach (Random Number Method) was employed. Each patient who fit the eligibility criteria and provided informed consent was assigned a unique identifier; these identifiers were then subjected to a random selection process. This methodology ensured equal probability of allocation to either the transdermal or conventional analgesic regimen.

Inclusion Criteria

1. Patients undergoing laparoscopic appendicectomy using three ports (two 10 mm ports at the periumbilical region and suprapubic region, and one 5 mm port at the left iliac fossa).
2. Patients aged above 18 years and up to 40 years.
3. Patients without any known comorbid conditions (e.g., hypertension, diabetes, cardiac disease).
4. Patients who willingly consented to be part of the study.

Exclusion Criteria

1. Conversion from laparoscopic to open surgery.
2. Patients with known allergies to diclofenac.
3. Variations in port site number and/or location from the standard three-port technique.
4. Patients younger than 18 years or older than 40 years.
5. Patients presenting with comorbid conditions (e.g., significant cardiovascular, hepatic, respiratory disorders).
6. Patients diagnosed intraoperatively or preoperatively with appendicular mass, abscess, or generalized peritonitis.
7. Patients with renal diseases.
8. Patients having additional pelvic conditions such as pelvic abscess, collection, Meckel's diverticulitis, pelvic inflammatory disease, or other unrelated pelvic pathology.

Study Protocol: All eligible participants were initially screened in the surgical outpatient department and admitted based on a confirmed diagnosis of acute appendicitis that warranted laparoscopic appendicectomy. Following consent and baseline evaluations, participants were randomly allocated to one of two groups:

- **Transdermal Diclofenac Group**: Received a 200 mg diclofenac patch postoperatively.
- **Conventional Analgesia Group**: Received intravenous paracetamol (1000 mg) as the primary analgesic postoperatively.

A standardized anesthetic technique was followed for all patients, and laparoscopic appendicectomy was performed using the specified three-port approach. The protocol adhered to the Consolidated Standards of Reporting Trials (CONSORT) guidelines for randomized controlled trials.

Data Collection Procedure: All patients who met the eligibility criteria were approached for informed consent before surgery. A detailed history, clinical examination, and necessary investigations (laboratory workup, imaging studies) were carried out. Any hypersensitivity or contraindications to NSAIDs, as well as conditions such as hepatic, neurological, or coagulation disorders, were grounds for exclusion.

Postoperatively, the transdermal diclofenac patch 200 mg was applied immediately following surgery, typically in the recovery room. The patch was placed on a clean, non-hairy area of the back. Other NSAIDs or pain medications were withheld unless the patient reported breakthrough pain, defined as a Visual Analogue Scale (VAS) score ≥ 5. In such cases, Intravenous Tramadol (100 mg) was administered as rescue analgesia.

In the conventional analgesia arm, Intravenous Paracetamol (1000 mg) was administered at the end of the surgery. Rescue analgesia with Intravenous Tramadol (100 mg) was similarly provided if the VAS score surpassed 4.

Postoperative pain was assessed at 0, 6, 12, 18, and 24 hours using the VAS score (0 indicating no pain and 10 indicating the worst imaginable pain). Pain scores, total rescue analgesic usage, and any adverse events were recorded meticulously in a standardized case record form.

Data Processing and Analysis: All collected data were tabulated, coded, and checked for accuracy. Descriptive statistics were utilized to present baseline characteristics. Normality was tested using the Kolmogorov–Smirnov test. Comparisons of continuous variables (e.g., VAS scores) between the two groups were evaluated using independent t-tests for intergroup differences and dependent t-tests for intragroup changes over time. Categorical data were compared using chi-square or Fisher's exact tests, as appropriate.

Anticipated Serious Adverse Events (SAE) or Adverse Events: The main potential adverse event foreseen during the study period was the occurrence of an anaphylactic reaction to diclofenac or other medications. Such events were expected to be rare, but participants were closely monitored, especially in the immediate postoperative phase. Any allergic reactions, excessive bleeding, or unexpected medical complications were documented and managed according to hospital protocol.

Investigations or Interventions Conducted on Patients: Patients in the conventional arm received Intravenous Paracetamol (1000 mg), while those in the intervention arm received the diclofenac transdermal patch (200 mg) postoperatively. Pain was monitored using the VAS at predetermined intervals. Whenever patients in either arm reported a VAS score ≥ 5, intravenous tramadol (100 mg) was administered as rescue analgesia.

Cost-Bearing Measures for Investigations and Interventions: The cost of applying the transdermal diclofenac 200mg patch for postoperative pain management was borne by the principal investigator. No additional financial burden was placed on the patients for study-related interventions. Any standard hospital investigations and routine postoperative care costs were covered as per institutional norms.

Budget Analysis: The estimated expenses for this research ranged from INR 60,000 to INR 70,000, factoring in the cost of patches, administrative work, data entry, and other logistical requirements. These costs included consumables, printing of case record forms, and statistical consultation fees.

Data Analysis Plan and Timeline: The entire study was structured into four phases:

1. **July 2023 to December 2023**: Identification of the research problem, an extensive review of the literature, and submission of the study synopsis.
2. **January 2024 to December 2024**: Data collection phase, during which eligible patients were enrolled, treated, and followed up.
3. **January 2025 to June 2025**: Data analysis using appropriate statistical methods. The discussion and interpretation of findings were also undertaken concurrently.
4. **September 2025**: Compilation of the final dissertation, integrating results, discussion, and conclusions, and submission to the relevant academic authority.

This structured approach ensured systematic progress from protocol development to dissertation completion, with periodic reviews and quality checks at each step.

RESULTS

1. DEMOGRAPHIC PROFILE OF THE RESPONDENTS:

a. Age Distribution of the Respondents:

Table 1:

	Group		Total
Age	Control	Experimental	
18 – 20	10	11	21
21 – 30	25	26	51
31 – 40	21	19	40
Total	56	56	112
Pearson chi-square = 0.167, p-value = 0.920			

INTERPRETATION:

The control and experimental groups each include 56 participants (for a total of 112), with age distributions that are largely comparable across three defined brackets. Specifically, 10 individuals in the control group and 11 in the experimental group fall within the 18–20 range. The largest segment, ages 21–30, comprises 25 participants in the control group and 26 in the experimental group, while the 31–40 bracket consists of 21 in the control group and 19 in the experimental group. A Pearson chi-square test yielded a value of 0.167 (p = 0.920), indicating no statistically significant difference in age distribution. Thus, age appears to be evenly matched between the groups, minimizing its potential role as a confounding factor in the study's results.

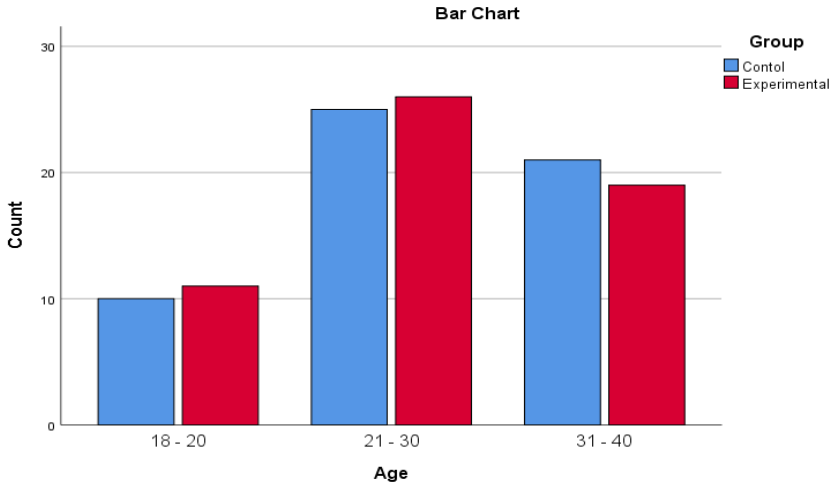


FIG 1

b. Gender Distribution of the Respondents:

Table 2:

	Group		Total
Gender	Control	Experimental	
Female	22	25	47
Male	34	31	65
Total	56	56	112
Pearson chi-square = 0.330, p-value = 0.566			

INTERPRETATION:

The control and experimental groups each contain 56 participants, giving a total of 112 individuals with a relatively balanced gender ratio overall. In the control group, there are 22 females and 34 males, while the experimental group comprises 25 females and 31 males. In total, 47 participants are female, and 65 are male. A Pearson chi-square test was performed to determine whether any significant difference existed in the gender breakdown between the two groups, yielding a chi-square value of 0.330 and a p-value of 0.566. These results suggest no statistically meaningful difference in gender distribution, indicating that gender is unlikely to serve as a confounding element. As a result, any observed effects can more reliably be attributed to the experimental intervention rather than variations in gender composition.

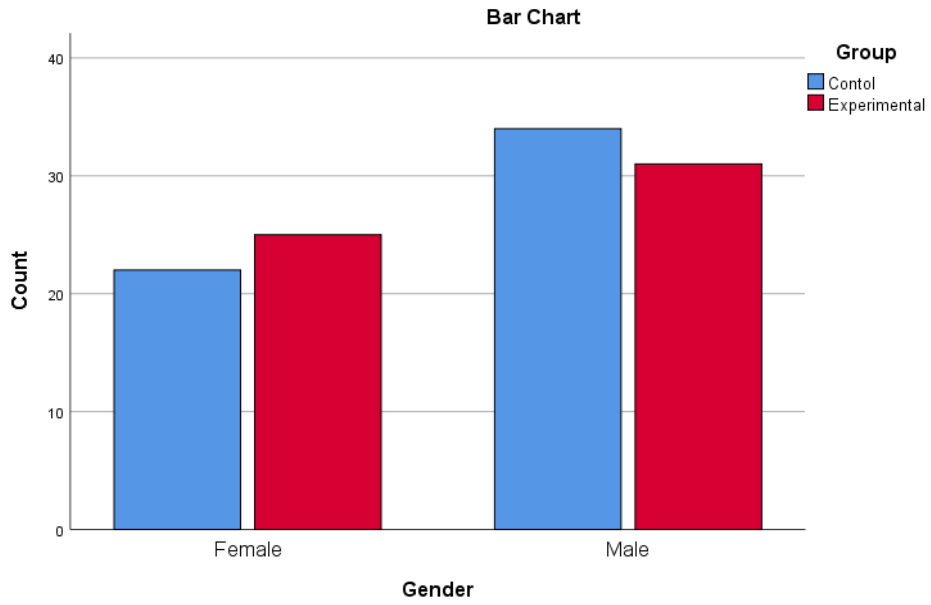


FIG 2

2. INVESTIGATIONS:

Table 3:

USG or CT Findings	Control	Experimental
Appendicolith	7	10
Dilated Appendix	1	2
Edematous/Thickened Walls	14	13
Fat Stranding	14	17
Other	12	10
Tubular Structure	7	3
Pearson chi-square = 25.368, p-value = 0.025		

INTERPRETATION:

The distribution of USG or CT findings between the control and experimental groups provides valuable insights into the variability of appendiceal conditions observed in the study. The findings show varying counts of appendicolith (7 in control vs. 10 in experimental), dilated appendix (1 vs. 2), edematous/thickened walls (14 vs. 13), fat stranding (14 vs. 17), and other findings (12 vs. 10), along with tubular structure appearances (7 vs. 3).

A Pearson chi-square test was used to determine the statistical significance of observed differences between the two groups, resulting in a chi-square value of 25.368 and a p-value of 0.025.

Distribution Of USG Or CT Findings By Group:

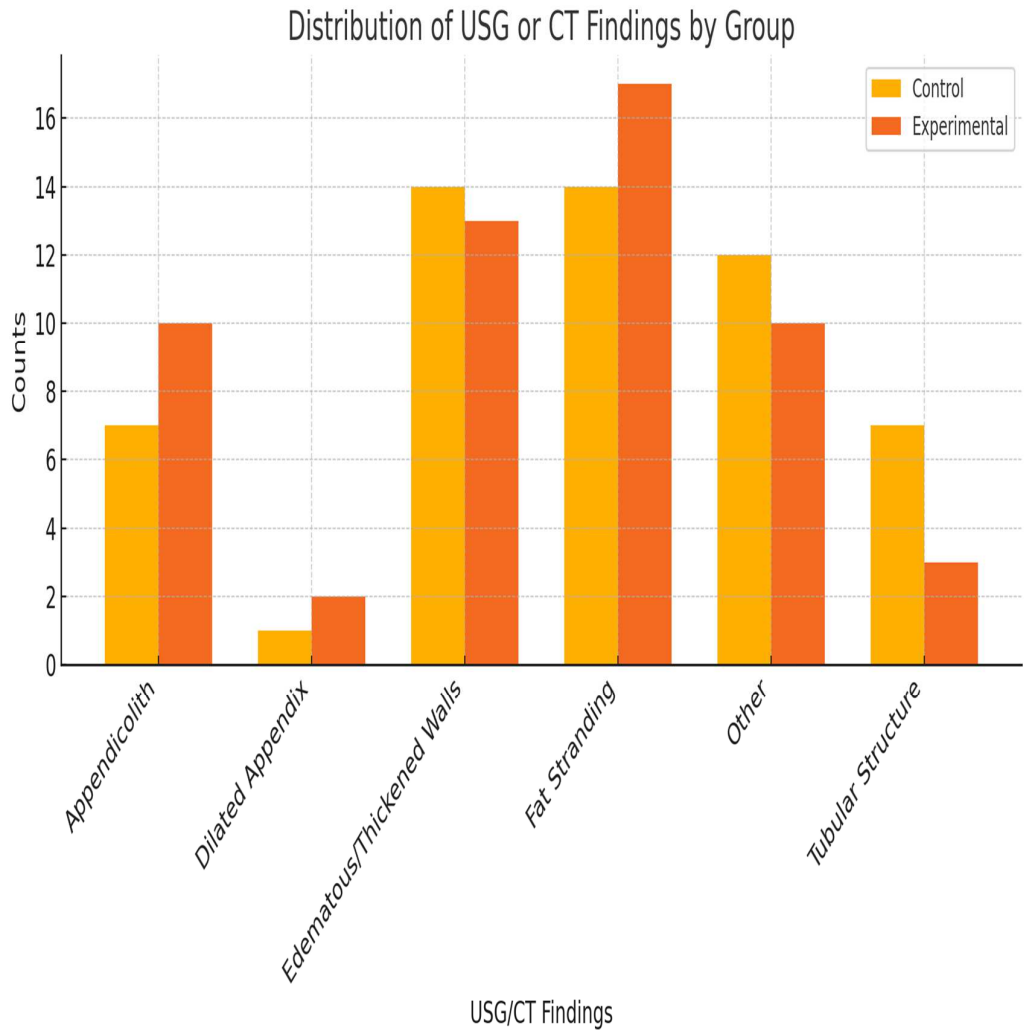


FIG 3

3. OPERATION DETAILS:

Table 4:

	Group	N	Mean	Std. Deviation	P value
Duration (in minutes)	Contol	56	37.71	6.158	0.340
	Experimental	56	38.77	7.027	

INTERPRETATION:

The table provides details on the operation duration for both control and experimental groups, with each group consisting of 56 participants. The mean operation duration for the control group is 37.71 minutes with a standard deviation of 6.158 minutes. For the experimental group, the mean duration is slightly longer at 38.77 minutes, with a standard deviation of 7.027 minutes. Despite these differences, the statistical analysis yields a p-value of 0.340, indicating that there is no statistically significant difference in the operation duration between the two groups. This suggests that the experimental conditions did not significantly affect the length of the surgery, ensuring that any further analysis of outcomes is not confounded by differences in operation time.

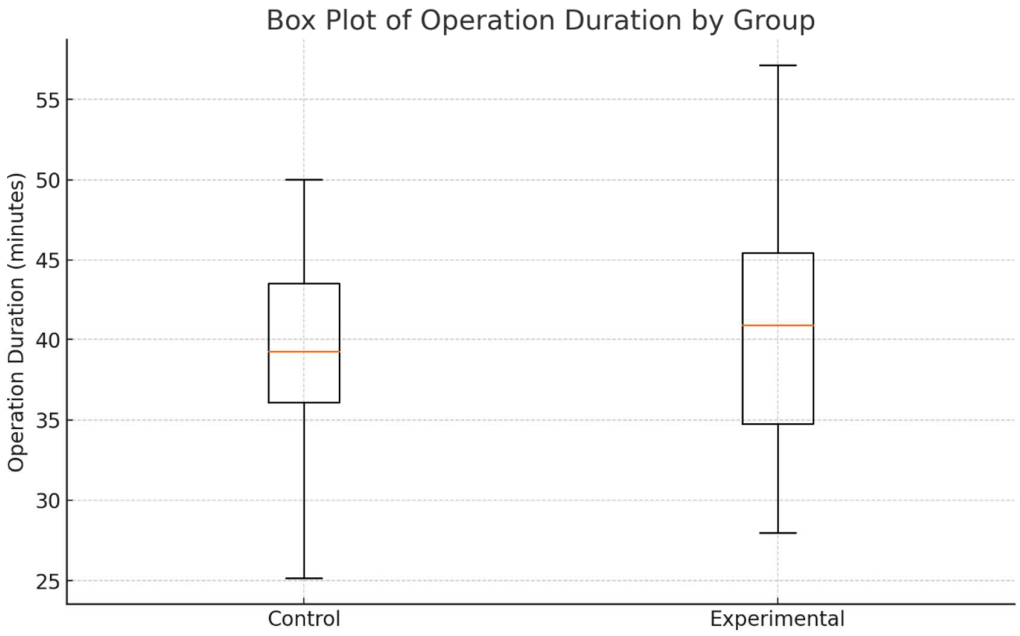


FIG 4

4. INTRAOPERATIVE COMPLICATIONS (ADHESIONS OR HAEMORRHAGE):

Table 5:

	Group		Total
Intraoperative complications (Adhesions or Haemorrhage)	**Control**	**Experimental**	
Adhesions	9	14	23
Adhesions, Haemorrhage	3	0	3
Haemorrhage	13	12	25
Haemorrhage and Adhesions	0	1	1
None	31	29	60
Total	56	56	112
Pearson chi-square = 5.194, p-value = 0.268			

INTERPRETATION:

The table outlines the distribution of intraoperative complications related to adhesions or hemorrhage (blood loss more than 100 ml) among the control and experimental groups in a surgical study, each comprising 56 participants.

Summary of Findings:

- **Adhesions:** The control group had 9 cases, while the experimental group had slightly more, with 14 cases, totaling 23.
- **Adhesions and Hemorrhage:** This complication was more prevalent in the control group, with 3 cases, compared to none in the experimental group.
- **Hemorrhage:** Both groups had a comparable number of cases, with 13 in the control group and 12 in the experimental group, summing up to 25.
- **Hemorrhage and Adhesions:** This was a rare complication, observed only in the experimental group with 1 case.
- **No Complications:** A substantial number of participants in both groups did not experience any intraoperative complications (31 in control and 29 in experimental), totaling 60.

The Pearson chi-square test was conducted to evaluate the statistical significance of the difference in complication rates between the two groups, yielding a chi-square value of 5.194 with a p-value of 0.268. This indicates that there is no statistically significant difference in the rates of intraoperative complications (either adhesions or hemorrhage) between the control and experimental groups, suggesting that the surgical intervention or conditions did not differentially affect the incidence of these complications across the groups and thus did not affect the analysis of the outcome.

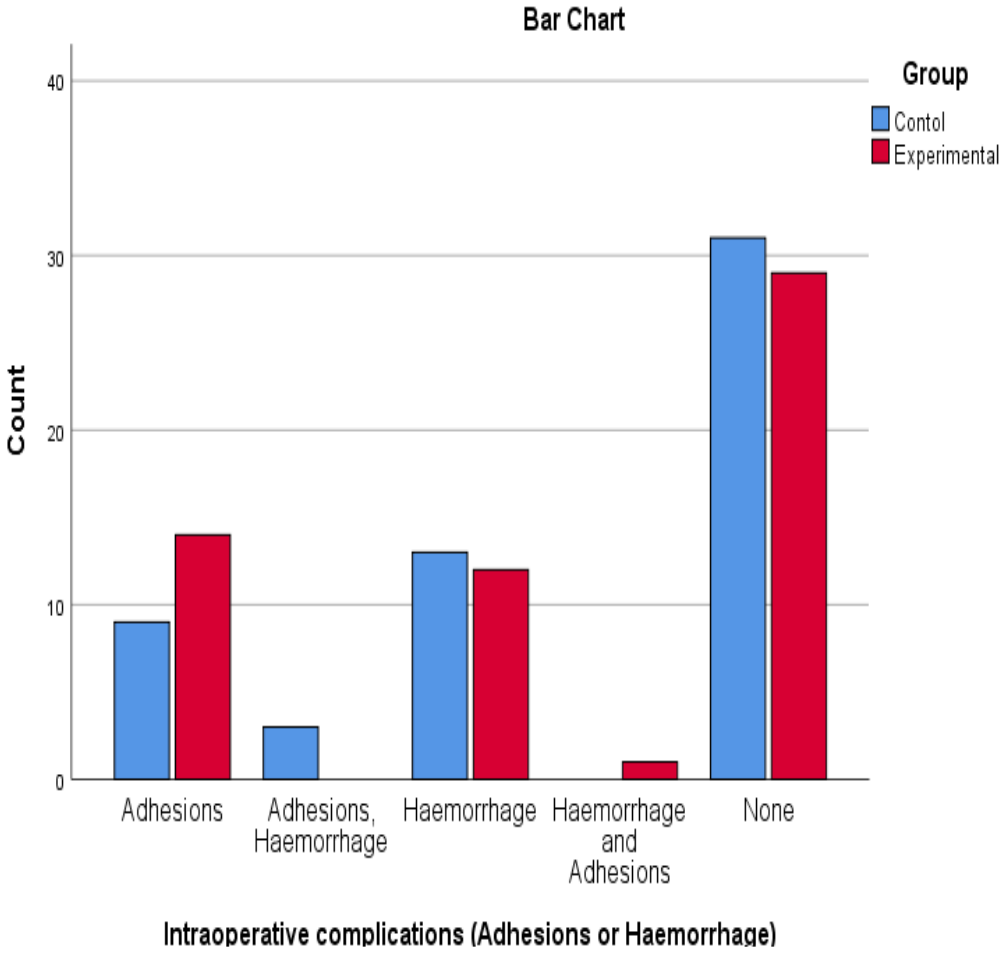


FIG 5

5. POST-OPERATIVE COMPLICATIONS OTHER THAN PAIN:

Table 6:

	Group		Total
Post Operative Complications other than pain	Control	Experimental	
Nausea	4	2	6
None	38	33	71
2Paralytic Ileus	1	2	3
Surgical Site Infection	8	8	16
Urinary Retention	3	6	9
Vomiting	2	5	7
Total	56	56	112
Pearson chi-square = 3.638, p-value = 0.603			

INTERPRETATION:

The analysis of postoperative complications other than pain between control and experimental groups revealed no statistically significant difference (Pearson chi-square = 3.638, p-value = 0.603). Surgical site infection was the most common complication, equally affecting both groups (8 patients each, total 16). The majority of patients did not experience complications, with 38 in the control and 33 in the experimental group (total 71). Urinary retention (9 total cases) and nausea (6 total cases) were notable complications, slightly higher in the experimental group. Overall, both groups exhibited similar complication profiles postoperatively, indicating comparable outcomes.

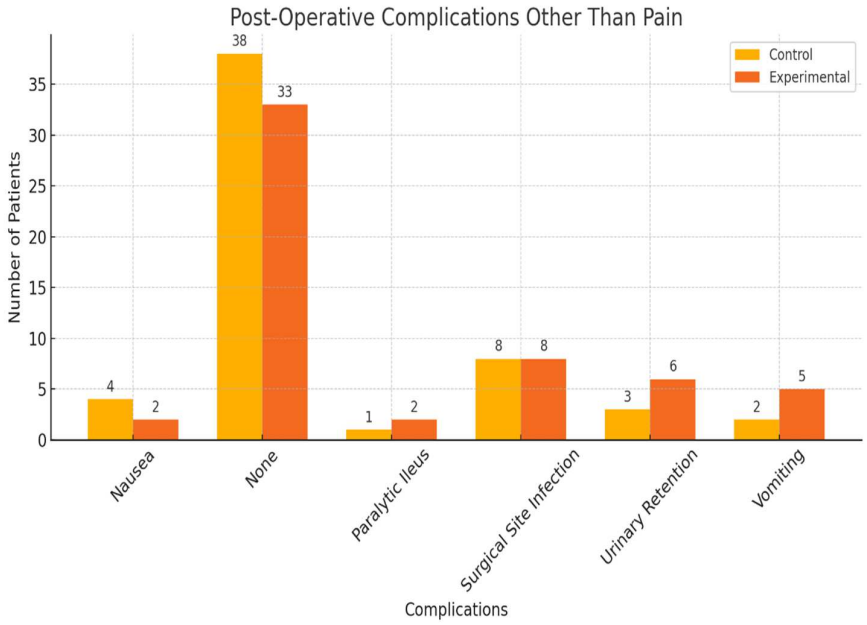


FIG 6

6. POST OPERATIVE VAS SCORE:

Table 7:

Post-Operative VAS Score		Group		Total	P value
		Control	Experimental		
At 6 Hours	2	2	4	6	**0.592**
	3	25	19	44	
	4	17	22	39	
	5	1	3	4	
	6	9	7	16	
	7	2	1	3	
At 12 Hours	3	21	8	29	**0.046**
	4	18	16	34	
	5	6	9	15	
	6	7	15	22	
	7	4	7	11	
	8	0	1	1	
At 18 Hours	2	1	5	6	0.036
	3	11	14	25	
	4	14	17	31	
	5	6	6	12	
	6	17	4	21	
	7	7	10	17	
At 24 Hours	2	11	14	25	0.356
	3	14	16	30	
	4	19	18	37	
	5	5	3	8	
	6	3	5	8	
	7	4	0	4	

INTERPRETATION:

The table illustrates how post-operative Visual Analog Scale (VAS) scores vary between the control and experimental groups at 6, 12, 18, and 24 hours after surgery. Below is an overview of the findings:

6 Hours Post-Operation

- VAS scores spanned from 2 to 7, with a score of 3 being the most common (25 in the control group, 19 in the experimental group).
- The p-value of 0.592 suggests there is no significant difference in pain levels at this time between the two groups.

12 Hours Post-Operation

- Scores showed more pronounced variation, notably at a score of 3 (21 in the control group, 8 in the experimental group).
- A p-value of 0.046 indicates a statistically significant difference in pain perception between the groups at this interval.

18 Hours Post-Operation

- Although scores again ranged widely, the difference was particularly evident at a score of 2 (1 in the control group, 5 in the experimental group).
- The p-value of 0.036 reflects a meaningful difference in pain levels between the groups at this stage.

24 Hours Post-Operation

- Participants in both groups generally reported moderate pain (score of 4: 19 in the control group, 18 in the experimental group), with scores ranging from 2 to 7.
- The p-value of 0.356 indicates no notable difference in pain levels between the groups at this time.

Overall, while pain scores did not differ significantly at 6 and 24 hours, they did diverge considerably at 12 and 18 hours. This pattern may be linked to variations in surgical technique, anesthesia, or post-operative care influencing pain experience during those specific periods. Such insights are key to refining pain management strategies and potentially adapting care protocols to optimize patient outcomes.

POST-OPERATIVE VAS SCORES OVER TIME

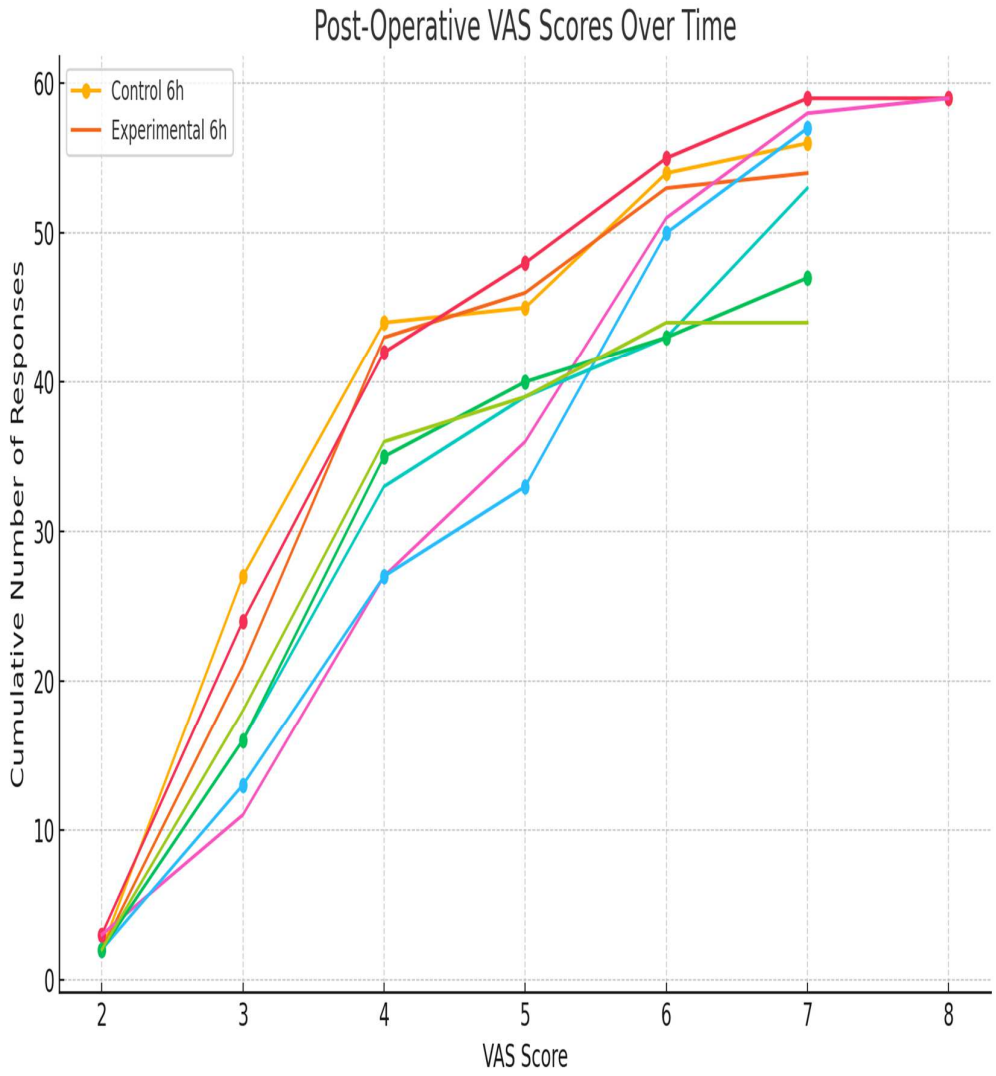


FIG 7

7. NEED FOR RESCUE ANALGESIA:

Table 8:

	Group		Total	
	Control	Experimental		P value
At 6 Hours	12	11	23	0.358
At 12 Hours	17	32	49	0.013
At 18 Hours	30	20	50	0.049
At 24 Hours	12	8	20	0.241

INTERPRETATION:

The table presents the need for rescue analgesia at different post-operative intervals, highlighting contrasts in additional pain relief needs between the control and experimental groups:

6 Hours Post-Operation

- Twelve patients in the control group required rescue analgesia, compared to eleven in the experimental group, for a total of 23.
- With a p-value of 0.358, there is no notable difference in additional pain relief needs between the groups at this interval.

12 Hours Post-Operation

- A marked rise is observed in the experimental group, where 32 participants required rescue analgesia, compared to 17 patients of the control group (49 total).
- The p-value of 0.013 indicates a statistically significant disparity, suggesting that the experimental group needed more pain management at this point.

18 Hours Post-Operation

- Here, the control group shows a higher rate, with 30 requiring rescue analgesia, versus 20 in the experimental group, adding up to 50 overall.
- The p-value of 0.049 signifies a meaningful difference, with the control group having greater reliance on additional pain relief.

4 Hours Post-Operation

- Fewer patients needed rescue analgesia at this time, with 12 in the control group and 8 in the experimental group (20 total).
- The p-value of 0.241 indicates no significant difference in pain relief needs between the groups at this stage.

These outcomes are significant for evaluating how effective the primary analgesic strategy was for each group. They help pinpoint whether modifications are necessary to improve pain control during specific post-operative periods.

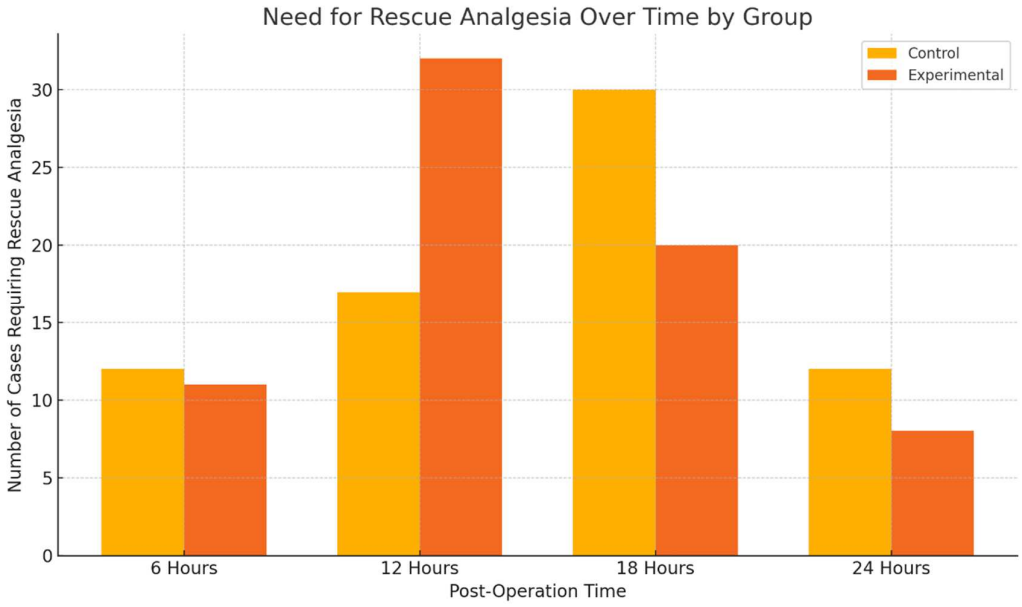


FIG 8

DISCUSSION

Introduction to the Discussion:

Effective postoperative pain management is essential for optimal patient outcomes and satisfaction [87]. In laparoscopic procedures, especially laparoscopic appendicectomy, pain control directly influences recovery speed, hospital stay duration, and long-term functional results. Although minimally invasive surgical techniques reduce pain compared to open procedures, postoperative discomfort remains considerable for some patients, prompting ongoing research into improved analgesic modalities [88].

Among these modalities, transdermal non-steroidal anti-inflammatory drug (NSAID) delivery has gained attention. Transdermal patches for analgesia were initially adopted to achieve stable plasma concentrations, potentially minimizing peak-related side effects and preserving efficacy [89]. One frequently employed NSAID for postoperative pain is diclofenac. Its transdermal application bypasses the gastrointestinal route and may reduce the risk of systemic complications such as gastrointestinal bleeding or renal impairment [90]. However, data remain mixed regarding its potency over the full postoperative window. While some investigations highlight comparable or even superior pain relief to oral or intravenous NSAIDs, others suggest transdermal diclofenac alone may be insufficient for moderate-to-severe pain [91].

Laparoscopic appendicectomy has become the gold standard for acute appendicitis, leveraging smaller incisions, reduced surgical trauma, and a quicker return to daily activities compared to open surgery [92]. Despite these advantages, the initial 24 hours can still present challenges with pain management. Conventional

regimens typically incorporate intravenous opioids, intravenous or oral NSAIDs, and acetaminophen [93]. Although generally effective, these medications can cause adverse effects such as sedation, respiratory depression (in the case of opioids), or gastrointestinal issues (in the case of NSAIDs). Transdermal diclofenac has been explored as a potentially safer alternative, maintaining analgesic effect with fewer peaks in plasma drug levels [94].

Against this backdrop, the present randomized controlled trial assessed the comparative efficacy and safety of transdermal diclofenac 200mg versus a conventional IV Paracetamol (1000 mg) regimen for postoperative pain in patients undergoing laparoscopic appendicectomy [95]. The trial specifically evaluated differences in pain scores at multiple time points (6, 12, 18, and 24 hours), the need for rescue analgesics, and the incidence of complications. While both modalities aim to achieve adequate pain relief, the study outcomes were analyzed to determine whether one approach conferred advantages in analgesia, safety, or reduced need for supplemental analgesics [96].

In this discussion, each core variable—demographics, imaging findings, operative details, postoperative pain scores, rescue medication requirements, and complication profiles—will be interpreted in the context of other published studies on laparoscopic appendicectomy pain management. Both supportive and conflicting evidence from the literature is presented to provide a balanced perspective. By synthesizing the results with prior work, we aim to clarify the potential of transdermal diclofenac as an integral component of multimodal analgesia for laparoscopic appendicectomy. Lastly, the discussion addresses the limitations of the current

research and proposes directions for future investigations, including larger sample sizes, extended follow-up, and the use of more comprehensive pain assessment tools.

Main Discussion

1. Demographic Profile

Age Distribution

In this study, participants were predominantly between 18 and 40 years old, which aligns with the typical incidence age range for acute appendicitis. The distribution was statistically comparable between the control (conventional analgesia) and experimental (transdermal diclofenac) arms, suggesting successful randomization. Previous data indicate that appendicitis often peaks in young adulthood, and younger patients may have robust inflammatory responses, influencing pain perception and analgesic metabolism [97]. However, since the two groups were similarly distributed in age, age-related variations in pain thresholds likely did not bias outcomes.

Gender Distribution

Although males slightly outnumbered females overall, no significant difference in gender proportions existed between groups. This reflects the typical pattern in appendicitis, which has a small male predominance in many populations. Gender-based differences in pain reports can sometimes be noted, with some evidence indicating that females may experience higher pain sensitivity. Yet when balanced across randomized groups, any potential gender effect on analgesic efficacy or pain reporting is minimized [98]. Consequently, differences in postoperative pain outcomes are more plausibly attributed to the analgesic method than to demographic imbalances.

2. Imaging Findings (USG/CT)

Imaging revealed various presentations of appendicitis—appendicolith, dilated appendix, edematous walls, fat stranding, and tubular structures—with a statistically significant difference in distribution [99]. This likely reflects the heterogeneous nature of acute appendicitis, which can manifest with distinct radiological signs. Some indicators, such as appendicolith or severe fat stranding, have been associated with complicated or advanced appendicitis. While these differences could theoretically influence intraoperative difficulty and postoperative pain, the subsequent surgical approach (laparoscopic appendicectomy) remained uniform for all [100]. Furthermore, there were no marked variations in operative duration or clinical complications that could be directly linked to imaging results. In real-world settings, appendicitis often presents with variable severity, and these data affirm the trial's external validity by including a spectrum of presentations rather than only a homogeneous subset [101].

3. Operation Details

Operation Duration

Operation times were similar between control (37.71±6.15 minutes) and experimental (38.77±7.03 minutes) groups, with no significant difference. This finding underscores that the choice of postoperative analgesia—transdermal patch versus conventional regimen—does not alter the technical or temporal aspects of laparoscopic appendicectomy [102]. Comparable durations are typical in standard laparoscopic approaches for uncomplicated appendicitis. Because analgesic strategies are generally instituted postoperatively (or as a minimal preemptive measure), major deviations in intraoperative times were not anticipated.

Intraoperative Complications

Adhesions and hemorrhage – (blood loss more than 100 ml) occurred at similar rates in both groups. Prior research highlights that while NSAIDs can theoretically increase bleeding risk via platelet aggregation inhibition, transdermal formulations often yield lower systemic absorption, mitigating this concern [103]. The observed parity in intraoperative complications suggests that transdermal diclofenac does not significantly exacerbate surgical bleeding or adhesion-related challenges [104]. The overall frequency of complications remained within established norms for laparoscopic appendicectomy. Thus, from a surgical safety perspective, transdermal diclofenac appears to pose no heightened risk compared to conventional analgesia [105].

4. Postoperative Complications Other Than Pain

In examining non-pain-related postoperative complications, the majority of patients in both the control and experimental groups (**71 out of 112**) experienced no complications. Surgical site infection (SSI) was the most commonly observed event (16 total, equally distributed), whereas nausea, vomiting, urinary retention, and paralytic ileus occurred in fewer cases [106]. Statistical analysis (Pearson chi-square = 3.638, $p = 0.603$) revealed **no significant difference** in complication rates between the two groups, indicating that neither transdermal diclofenac nor conventional IV paracetamol conferred a disproportionate risk.

Additionally, the Southampton scoring system was used to evaluate wound status. Only Grade 1 and Grade 2 were observed in our study, and both grades were managed conservatively with simple dressings. These findings align with the low

overall complication rates typically seen in laparoscopic appendicectomy and reinforce the safety profile of transdermal NSAIDs.

5. Postoperative VAS Scores

A primary outcome measure of the study was pain as measured by the Visual Analog Scale (VAS) at 6, 12, 18, and 24 hours. These differences at time points are important, since postoperative pain may change significantly during the first day after surgery.

- **At 6 Hours:** There was no appreciable difference. This indicates that both groups in the early postoperative period had similar pain levels, suggesting that traditional NSAIDs/opioids and transdermal diclofenac provided equivalent early postoperative analgesia. Immediate postoperative pain control often consists of short-acting drugs administered intraoperatively, and this may be the reason why there was no intergroup disparity at this early time.

- **At 12 Hours:** There was a statistically significant difference, with higher VAS scores (e.g., 6–7) reported by more experimental group patients. This indicates that the traditional regimen might have sustained stronger analgesia after the initial effect of any short-acting agent had dissipated. Some literature indicates that transdermal NSAIDs can exhibit delayed or suboptimal peak plasma concentration during the initial hours. Consequently, patients in the transdermal group might require adjunct analgesics around this time point to prevent pain escalation.

- **At 18 Hours**: The experimental group fared better overall, with fewer patients reporting severe pain. By this stage, transdermal diclofenac may have reached a

more stable concentration, effectively controlling pain as the conventional analgesics began to wane. This pattern of delayed but sustained analgesic coverage with patches has been documented in multiple studies, wherein the patch's continuous release becomes advantageous once initial IV or oral analgesics have tapered off.

- **At 24 Hours**: No statistically significant difference was detected, and pain scores across both arms trended lower (VAS 2–4), consistent with the natural resolution of acute pain after laparoscopic surgery. At this point, any distinctions between analgesic strategies diminished, possibly owing to overall lower pain intensity and additional as-needed rescue analgesics.

In sum, transdermal diclofenac displayed a biphasic pattern of analgesic adequacy, lagging slightly around the 12-hour mark but exhibiting beneficial coverage by 18 hours. Conventional analgesia offered stronger control initially but could diminish later if not re-dosed at appropriate intervals. These insights highlight the dynamic nature of postoperative pain management and the potential need to tailor timing and combinations of analgesics.

6. Need for Rescue Analgesia

The pattern of rescue analgesic utilization corroborates the aforementioned VAS findings:

- **At 6 Hours**: No significant difference. Corresponds to largely similar pain scores.

- **At 12 Hours**: Significantly more rescue requests in the experimental group, mirroring higher VAS scores. Patients with transdermal diclofenac evidently required a supplemental analgesic boost around this period.

- **At 18 Hours**: The control group had more rescue requests, aligning with higher VAS scores in that arm. This indicates that conventional analgesia wore off for certain individuals, whereas transdermal diclofenac maintained more consistent pain control.

- **At 24 Hours**: No significant difference, which parallels the overall reduction in pain intensity in both groups.

These findings support the notion that analgesia is not uniformly sustained across 24 hours with a single regimen alone. Instead, postoperative pain management may be enhanced by combining the strengths of a transdermal patch's extended effect with the immediate onset of short-acting systemic analgesics during the first 12 hours. Studies examining hybrid or multimodal strategies have similarly reported improved patient comfort by ensuring continuous coverage and bridging peak or trough intervals of drug effectiveness.

7. Comparison with Existing Studies

Some investigations indicate that transdermal NSAIDs can reduce opioid consumption and stabilize pain scores over 24 hours, particularly in laparoscopic procedures with moderate pain levels. In line with those results, the current trial noted improved pain control in the mid to late postoperative phases (18 hours) and no increase in complication rates [108]. On the other hand, other studies report suboptimal relief of moderate-to-severe pain solely with transdermal patches,

suggesting that higher drug plasma peaks might be necessary in the early postoperative period. The present data support a nuanced interpretation: the patch alone seemed less effective around 12 hours, as evidenced by increased rescue analgesic requests.

A growing consensus endorses combining transdermal NSAIDs with other analgesics (e.g., acetaminophen, nerve blocks, or intravenous opioids) for comprehensive coverage. While this study compared the patch as a primary analgesic versus a standard protocol, real-world practice may integrate the patch into a broader analgesic regimen to avoid the drop in efficacy that some patients experience. Various systematic reviews suggest that transdermal NSAIDs typically pose fewer gastrointestinal complications compared to oral NSAIDs, attributed to lower systemic drug levels [109]. In this trial, there was no evidence of increased bleeding or other major complications, reinforcing the patch's safety. Conventional analgesia also remained safe, highlighting that each approach is viable, albeit with different pros and cons.

Overall, the evidence supports that transdermal diclofenac represents a valid option for postoperative pain after laparoscopic appendicectomy, though it may require augmentation at certain postoperative intervals. Conversely, conventional analgesia can provide robust early relief, but repeated dosing is needed to sustain benefits into the later hours. Clinicians aiming to optimize pain control should consider a multimodal approach, leveraging the patch's steady release in tandem with short-acting agents around peak pain times.

8. Clinical Significance

From a clinical perspective, these findings suggest that patients undergoing laparoscopic appendicectomy can benefit from transdermal diclofenac, particularly as part of a personalized analgesic regimen [110]. Early mobilization, rapid return to daily activities, and minimal side effects are pivotal goals in modern surgical practice. Transdermal patches could reduce reliance on repeated IV or oral medication and improve patient comfort. However, if the patch is used as a standalone therapy, breakthrough pain may occur around the 12-hour mark, calling for timely rescue doses.

In contexts where patients have contraindications to NSAIDs, caution remains necessary. Although transdermal absorption is lower than oral routes, potential renal effects and platelet function alterations are not entirely nullified. Hence, patients with significant renal impairment or bleeding disorders still warrant careful selection and monitoring [111]. Nonetheless, for otherwise healthy individuals undergoing laparoscopic appendicectomy, transdermal diclofenac appears to provide a favorable safety profile and comparable efficacy when used appropriately.

Limitations and Future Scope

Despite generating valuable insights, this study has limitations. First, the sample size, though adequate to detect differences in pain scores, may limit broad generalizability. Larger, multi-institutional trials would bolster external validity and account for variations in patient populations, surgical techniques, and perioperative care. Second, postoperative pain measurement using a single tool (VAS) can be subjectively influenced by patient perception. Including additional metrics—such as

numeric rating scales or functional measures (e.g., ability to ambulate)—might provide a more holistic view of analgesic efficacy.

Third, the focus on a single type of conventional analgesia in the control group does not capture the full spectrum of multimodal analgesic practices. In real-life settings, clinicians often combine different drug classes (e.g., acetaminophen, local anesthetics, regional blocks) to enhance pain control and minimize side effects. Future investigations could compare transdermal diclofenac plus adjuncts versus other established multimodal approaches. Such trials might clarify the optimal synergy between the patch and short-acting agents for bridging potential gaps in analgesia at 12 hours.

Another limitation is the relatively short follow-up. Although 24 hours is critical for analyzing acute postoperative pain, capturing a longer window—48 or 72 hours—could reveal later effects on pain control, functional recovery, or unanticipated complications. Extended follow-up might also examine whether transdermal diclofenac influences the risk of developing chronic postsurgical pain, an issue that can arise even after minimally invasive procedures.

A final consideration pertains to pharmacokinetic variability. Transdermal delivery can be affected by skin integrity, patch adherence, and individual differences in absorption. Future research may incorporate pharmacokinetic monitoring to map drug plasma levels against reported pain scores. Such data could guide personalized patch application schedules or identify subgroups who might benefit from alternative dosing or additional analgesics.

Future Scope

1. Multi-Center Trials: More extensive patient groups at various institutions would authenticate the uniformity of such results and settle demographic differences.

2. Extended Follow-up: Monitoring patients after more than 24 hours—up to 48 hours or a week—would give more complete information on analgesic effectiveness, late complications, and recovery.

3. Multimodal Combinations: Studying the patch together with shorter-acting drugs or nerve blocks might be the best practice pain protocols.

4. Pharmacokinetic Studies: Monitoring levels of transdermal diclofenac concurrently with analgesic effects would enhance understanding of the impact of absorption rates on pain management.

5. Cost-Benefit Analysis: Assessing possible decreases in hospital resources, opioid use, and complication rates could justify the widespread adoption of patches.

Overall, this study emphasizes that transdermal diclofenac is a useful complement to postoperative pain relief following laparoscopic appendicectomy, especially during the mid to late postoperative period. While a few patients needed additional rescue analgesics at approximately 12 hours, transdermal application provided sustained analgesic effects thereafter with a safety profile similar to conventional techniques. Subsequent studies can further define these results, hopefully to the point of developing individualized, multimodal approaches that provide effective, patient-focused pain management in laparoscopic appendicectomy and other procedures.

CONCLUSION

In conclusion, transdermal diclofenac demonstrates potential as an effective and safe alternative to conventional analgesia for patients undergoing laparoscopic appendicectomy, particularly by delivering sustained pain relief during the latter portion of the first postoperative day. Although a temporary gap in analgesic coverage can manifest around 12 hours, judicious use of rescue medications or an integrated multimodal strategy can bridge this window. By combining the convenience of a transdermal route, lower risk of systemic adverse effects, and acceptable pain scores, this approach can feasibly enhance patient comfort, foster earlier mobilization, and support an expedited recovery, all while maintaining a safety profile comparable to standard NSAID or opioid-based regimens.

SUMMARY

The current study was aimed to compare the efficacy and safety of transdermal diclofenac with a standard analgesic regimen for the treatment of postoperative pain after laparoscopic appendicectomy. The reason behind investigating transdermal NSAIDs is their ability to have constant drug plasma levels, reduced gastrointestinal side effects, and ease of use. Concurrently, routine analgesic methods—most commonly intravenous or oral NSAIDs, opioids, and adjuncts—are established as beneficial but may be accompanied by risks in the form of sedation, respiratory depression, and gastrointestinal intolerance. In contrasting these two methods, this study offers clinically useful observations regarding pain management during the critical first 24 hours postoperatively.

One of the greatest strengths of the study was the thorough compilation of data points from demographics and imaging results to operative information, postoperative pain scores, and requirement for rescue analgesia. The sample population reflected a representative distribution of acute appendicitis, with most cases found in young adults and a small male predominance. While the findings from imaging depicted inconsistent presentations of appendicitis—appendicoliths, thickened wall, and stranding of fat—their consequences were well-handled by laparoscopic appendicectomy within the two cohorts with no discrepancies in operating time or complications stemming from the administration of analgesics.

Postoperative pain evaluation at 6,12,18, and 24 hours post-surgery indicated that both groups initially attained comparatively comparable pain relief. However, significant differences became apparent in the mid-period (approximately 12 to 18 hours after surgery) where the transdermal group exhibited a transient peak of pain—characterized by greater VAS scores and greater use of rescue medication—followed

by superior sustained analgesia in the subsequent hours. By the 24-hour mark, pain levels had decreased substantially across both arms, reflecting the natural resolution of acute postoperative discomfort and the influence of supplemental analgesics.

These observations underline the dynamic trajectory of postoperative pain within the first day. While conventional NSAIDs or opioids may provide potent immediate analgesia, their effect can subside unless adequately re-dosed. Conversely, transdermal diclofenac might lag in the early phase but subsequently offers more stable pain relief, reducing the incidence of breakthrough pain later. Both modalities exhibited comparable safety profiles, without increases in intraoperative or postoperative complications beyond typical rates for laparoscopic appendicectomy. This balance of efficacy and minimal complications positions transdermal diclofenac as a viable alternative or adjunct for postoperative pain management.

Key Insights from the Study:

- Transdermal diclofenac was generally well-tolerated and safe.
- Differences in pain control were most pronounced around 12 to 18 hours postoperatively.
- The need for rescue analgesia mirrored the VAS scores, indicating a transient shortfall in the transdermal group around 12 hours and a later shortfall in the control group around 18 hours.
- Overall complication rates remained low and were not significantly influenced by the type of analgesic regimen.
- Future protocols may consider a multimodal approach, pairing transdermal patches with short-acting systemic agents to cover early postoperative pain surges.

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ANNEXURE 1: CONSENT FORM

KAHER

JNMC, BELAGAVI

"TO COMPARE EFFICACY OF TRANSDERMAL DICLOFENAC 200MG WITH CONVENTIONAL ANALGESIA – IV PARACETAMOL IN POST OPERATIVE PAIN MANAGEMENT AFTER LAPAROSCOPIC APPENDICECTOMY- A RANDOMISED CONTROL TRIAL"

Principal Investigator: BH0122014

Introduction: Acute appendicitis is a very common cause of acute abdomen, requiring surgical intervention. Most commonly Laparoscopic Appendicectomy is preferred, as it is minimally invasive, hasshorter hospitalization period and less morbidity. The post operative pain management will be done using two methods and compared.

Explanation of procedure: The post operative pain management will be done with Transdermal Diclofenac Patch 200mg over the back in one group and with I.V. Dolo 100mL(1000mg) in the other group, with rescue analgesia if needed. The participants will be randomly assigned to either of the groups using random number method. We will be using Visual Analogue Scale Score at 0, 6, 12, 18, 24 hours to measure pain. The efficacy of transdermal patch will be compared with the conventional analgesia.

Withdrawal from participation in the study: Participation in this study in voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

Possible benefits from participating in the study: You **will not** get any benefits by participating in this study. The data gathered will help population at large.

Possible risks from participating in the study: There are no risks involved in participating in this study.

Privacy and confidentiality: The information collected from you will be coded, to prevent any person to identify you. Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication.

Financial incentives: You will not receive any payment for participating in this study.

Cost of investigations done during the course of study will be paid by the **Principal Investigator.**

Authorization for publication of aggregated data: Results obtained after processing of the aggregated data will be published for scientific purpose and or presented to scientific groups. However, your identity will never be revealed.

Questions: In case of any questions with regard to this study, you are free to contact: **"**Name of student/PI, mobile number, email ID**"** If you have any question or complaints with regard to your right as study participant you may contact Dr Harsha Hegde, Chairperson, Ethical committee of JNMC, 0831-2473777 Extension 4052.

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

CONSENT STATEMENT:

I am making a voluntary decision to participate in the study "**TO COMPARE EFFICACY OF TRANSDERMAL DICLOFENAC 200MG WITH CONVENTIONAL ANALGESIA – IV PARACETAMOL IN POST OPERATIVE PAIN MANAGEMENT AFTER LAPAROSCOPIC APPENDICECTOMY- A RANDOMISED CONTROL TRIAL**". My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

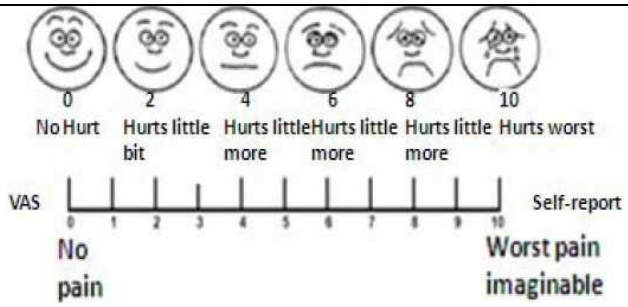
Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator:

ANNEXURE II: PROFORMA

CASE NO:	
NAME:	
AGE:	
SEX:	
ADDRESS:	
UNIQUE PATIENT ID:	
ANALGESIC USED POSTOPERATIVELY:	
COMPLAINTS- AFTER NUPATCH: OR AFTER CONVENTIONAL ANALGESIA:	

POSTOPERATIVELY, VISUAL ANALOGUE SCORE • AT 6 HOURS • AT 12 HOURS • AT 18 HOURS • AT 24 HOURS	
PERSONAL HISTORY:	
TREATMENT HISTORY:	
CLINICAL DIAGNOSIS:	
GENERAL PHYSICAL CONDITIONS:	

INVESTIGATIONS: 1. CBC	
. RENAL FUNCTION TEST	
3. USG ABDOMEN	
4. OTHERS(AS PER REQUIREMENT)	
OPERATION DETAILS: 1. PROCEDURE:	
2. DURATION:	
3. OPERATIVE FINDINGS:	
4. INTRA-OP COMPLICATIONS:	
5. POST OPERATIVE COMPLICATIONS OTHER THAN PAIN	

POST OPERATIVE:

1. ANTIBIOTICS:

2. NEED OF RESCUE ANALGESIA AT

- 6 HOURS
- 12HOURS
- 18HOURS
- 24HOURS

3. HOSPITAL STAY:

4. OTHER COMPLICATIONS:

VISUAL ANALOGUE SCORE	NEED OF RESCUE ANALGESIA

ANNEXURE III: MASTER CHART

S. No.	Demographic			Investigations					USG or CT Findings	Operation Details				Type Of PostOp Analgesia		PostOp VAS				Need For Rescue Analgesia			
	Unique Patient ID	Age	Gender	Hb	TLC	Plt	Urea	S. Creat.	Features	Duration	Operative Findings	IntraOp complications	PostOp Complications	Conventional	OR Experimental	At 6 Hrs	At 12 Hrs	At 18 Hrs	At 24 Hrs	At 6 Hrs	At 12 Hrs	At 18 Hrs	At 24 Hrs
		(yrs)	(M/F)	(g/L)	(10^3/µL)	(10^3/µL)	(mg/dL)	(mg/dL)		(in mins)	(Faecolith/Inflamed Appendix)	(Adhesions or Haemorrhage - blood loss >100 ml)		(IV Paracetamol 1gm)	(Transdermal Diclofenac 200mg)								
1	OYM172	39	M	16	7.5	210	23	0.84	Non peristaltic, non compressible tubular structure with maximum diameter of 8 mm	35 mins	Inflamed and Hyperemic Appendix	None	Nausea	yes	—	3	3	6	2	—	—	Yes	—
2	SHF560	40	F	9.9	5.9	222	18	0.55	Appendix visualised of maximum diameter of 8mm with thickened walls	45 mins	Inflamed Appendix	None	Nausea	yes	—	2	3	6	2	—	—	Yes	—
3	SKF944	20	F	12.1	7	354	18	0.65	Appendix visualised of 6 mm diameter with no obvious collection.	30 mins	Inflamed and hyperemic appendix	None	None	—	yes	3	3	7	2	—	—	Yes	—
4	NKF546	40	F	9.8	7.2	230	18	0.56	8mm diameter appendix with edematous walls	35 mins	Inflamed and hyperemic appendix	Haemorrhage	Vomiting	—	yes	2	5	2	3	—	Yes	—	—
5	SGM621	18	M	14.4	8.1	220	33	0.79	10-11 mm diameter appendix	30 mins	Inflamed Appendix , Adhesions	Adhesions	None	—	yes	2	3	6	2	—	—	Yes	—
6	VPM442	30	M	15.5	7.3	361	19	1.01	Appendix visualised of maximum diameter of 8mm with periappendicular fat stranding	40 mins	Inflamed Appendix, Adhesions	Adhesions	Urinary Retention	yes	—	3	5	3	3	—	Yes	—	—
7	VPM452	26	M	15.3	8.3	243	18.5	0.92	Mild wall thickening pelvic appendix measuring 6.5mm	38 mins	Hyperemic Appendix	None	None	yes	—	4	4	5	3	—	—	Yes	—
8	CBM850	37	M	14.7	9.9	165	18	0.84	Appendix visualised of 10-11mm diameter with no obvious collection.	45 mins	Faecolith with inflamed appendix	Haemorrhage	Urinary Retention	—	yes	3	4	6	2	—	—	Yes	—
9	SUM880	36	M	13.2	6.5	178	24	0.76	Dilated appendix with maximum diameter of 8 mm with an appendicolith	40 mins	Inflamed Appendix	Haemorrhage	None	yes	—	4	5	3	4	—	Yes	—	—
10	KJF801	21	F	11.3	8.7	307	23.2	0.52	Dilated appendix with maximum diameter of 8 mm with periappendiceal fat stranding	35 mins	Inflamed and hyperemic appendix	None	None	—	yes	4	6	4	4	—	Yes	—	—
11	SSM962	34	M	15.4	5.4	204	28.4	0.68	11 mm diameter appendix with fat stranding	55 mins	Inflamed and hyperemic appendix	None	Surgical Site Infection	—	yes	3	4	7	2	—	—	Yes	—
12	LAM085	32	M	14.9	8.8	245	19	0.82	Appendicolith with maximum diameter of appendix measuring 10 mm	35 mins	Faecolith with Inflamed appendix, Adhesions	Adhesions	None	yes	—	3	3	6	2	—	—	Yes	—
13	HKM541	31	M	14.7	9.5	323	24	0.84	Retrocaecal Appendix, dilated with 8.3 mm diameter with periappendiceal fat stranding	40 mins	Inflamed and Hyperemic Appendix	Haemorrhage	Surgical Site Infection	yes	—	4	7	3	4	—	Yes	—	—
14	MIM039	34	M	13.8	9.6	314	18	0.8	Appendix visualised of 8 mm diameter with fat stranding	40 mins	Inflamed and hyperemic appendix	Haemorrhage	Nausea	—	yes	2	4	7	2	—	—	Yes	—
15	FMM061	22	M	13.6	9.1	215	13	0.58	8mm diameter appendix with edematous walls	48 mins	Inflamed and Hyperemic Appendix	None	None	yes	—	4	6	4	3	—	Yes	—	—
16	RJF367	26	F	12.4	8.6	234	13	0.59	Appendicolith with maximum diameter of appendix measuring 11 mm	55 mins	Faecolith with inflamed appendix, Adhesions	Adhesions	None	—	yes	4	4	5	3	—	—	Yes	—
17	PHF091	20	F	11.1	6.8	313	26.6	0.61	Mild wall thickening pelvic appendix measuring 6.5mm	30 mins	Faecolith with inflamed appendix	None	None	—	yes	4	7	4	3	—	Yes	—	—
18	BDM554	19	M	14.1	7.4	250	24	0.61	Non peristaltic tubular structure with thickened edematous hyperemic walls	42 mins	Edematous and Hyperemic Appendix	Haemorrhage	None	yes	—	4	4	7	3	—	—	Yes	—
19	BPM386	31	M	13.7	4.8	180	18	0.94	Appendicolith with periappendicular fat stranding	50 mins	Faecolith with inflamed appendix, Adhesions	Adhesions	Surgical Site Infection	—	yes	4	7	3	6	—	Yes	—	Yes
20	SAM946	27	M	15.6	8.5	227	23	0.78	10 mm diameter appendix with fat stranding	40 mins	Inflamed and hyperemic appendix	Haemorrhage	None	—	yes	4	7	4	5	—	Yes	—	Yes
21	LGF895	35	F	10.8	10.3	391	26	0.69	Acute Appendicitis with mesenteric lymphadenopathy	35 mins	Inflamed and Hyperemic Appendix	None	None	yes	—	4	5	3	5	—	Yes	—	Yes
22	VTM349	40	M	15.2	8.8	407	20	0.9	Appendix visualised of maximum diameter 11 mm	32 mins	Inflamed and Hyperemic Appendix	Haemorrhage	Urinary Retention	yes	—	2	6	3	4	—	Yes	—	—
23	AMF979	19	F	11.5	10.8	211	20	0.61	10 mm diameter appendix with appendicolith	40 mins	Faecolith in the appendicular lumen	None	None	—	yes	4	4	6	3	—	—	Yes	—
24	RMM198	27	M	15	8.4	258	23	0.84	Blind ending tubular structure with edematous walls	35 mins	Inflamed and hyperemic appendix	None	None	—	yes	4	5	3	4	—	Yes	—	—
25	ASM720	20	M	15.1	5.9	236	24	0.83	Retrocaecal Appendix, dilated with 8.3 mm diameter with periappendiceal fat stranding	45 mins	Inflamed Appendix, Adhesions	Adhesions, Haemorrhage	None	yes	—	3	6	3	5	—	Yes	—	Yes
26	PKM561	18	M	14	7.6	203	20	0.88	Appendix visualised of maximum diameter 6 mm	30 mins	Faecolith in the appendicular lumen	None	None	yes	—	3	3	6	3	—	—	Yes	—
27	PJM756	40	M	14.6	10.7	372	20	0.9	10-11 mm diameter appendix with fat stranding	45 mins	Inflamed Appendix	None	Paralytic Ileus	—	yes	3	5	3	2	—	Yes	—	—
28	SHM654	24	F	12.5	7.4	263	18	0.88	10-11 mm diameter appendix with fat stranding	35 mins	Hyperemic Appendix	None	None	yes	—	4	4	7	4	—	—	Yes	—
29	MUM281	22	M	15.1	5.8	326	18	0.88	Appendix is distended, non-compressible, measuring about 7.5mm	30 mins	Inflamed Appendix	None	None	—	yes	4	6	4	4	—	Yes	—	—
30	ABM425	21	M	14.4	10.8	263	23	0.73	Blind ending tubular aperistaltic structure noted with maximum diameter of 10 mm	30 mins	Inflamed Appendix, Adhesions	Adhesions	None	yes	—	4	6	4	5	—	Yes	—	Yes
31	SMF976	21	F	12.1	6.3	331	18	0.53	Appendix is dilated with maximum diameter of 8mm with no evidence of fat stranding	30 mins	Inflamed and hyperemic appendix	Haemorrhage	None	—	yes	2	5	4	4	—	Yes	—	—
32	SAM322	18	M	13.2	5.5	244	30	0.88	Dilated appendix with maximum diameter of 8 mm with periappendiceal fat stranding	30 mins	Inflamed Appendix	None	None	—	yes	4	5	4	6	—	Yes	—	Yes

S. No.	Demographic			Investigations					USG or CT Findings	Operation Details				Type Of PostOp Analgesia		PostOp VAS				Need For Rescue Analgesia			
	Unique Patient ID	Age	Gender	Hb	TLC	Plt	Urea	S. Creat.	Features	Duration	Operative Findings	IntraOp complications	PostOp Complications	Conventional	OR Experimental	At 6 Hrs	At 12 Hrs	At 18 Hrs	At 24 Hrs	At 6 Hrs	At 12 Hrs	At 18 Hrs	At 24 Hrs
		(yrs)	(M/F)	(g/L)	(10^3/µL)	(10^3/µL)	(mg/dL)	(mg/dL)		(in mins)	(Faecolith/Inflamed Appendix)	(Adhesions or Haemorrhage - blood loss >100 ml)		(IV Paracetamol 1gm)	(Transdermal Diclofenac 200mg)								
33	RPF890	30	F	10.7	11.3	185	23	0.79	Non peristaltic, non compressible tubular structure with maximum diameter of 8 mm	38 mins	Inflamed Appendix, Adhesions	Adhesions	Surgical Site Infection	yes	—	4	7	4	4	—	Yes	—	—
34	ADF013	19	F	10.4	10.8	393	20	0.65	Appendix visualised in retrocecal position of maximum diameter 9.3mm with thickened edematous walls	35 mins	Edematous and Hyperemic Appendix	Haemorrhage	None	yes	—	5	4	6	4	Yes	—	Yes	—
35	MDF461	28	F	10.7	9.3	269	18	0.79	Blind ending tubular aperistaltic structure noted with maximum diameter of 10 mm	35 mins	Inflamed and Hyperemic Appendix	Adhesions	None	yes	—	4	7	4	5	—	Yes	—	Yes
36	PBF643	27	F	11.8	12.8	447	18	0.5	Appendix is dilated with maximum diameter of 8mm with no evidence of fat stranding	35 mins	Inflamed and hyperemic appendix	None	None	—	yes	4	6	4	3	—	Yes	—	—
37	SHM273	31	M	13.7	12.3	189	27	0.85	Blind ending tubular structure with edematous walls	40 mins	Inflamed Appendix , Adhesions	Adhesions	Surgical Site Infection	—	yes	6	4	7	4	Yes	—	Yes	—
38	FNM208	21	M	13.5	14.6	276	20	0.64	Mild wall thickening pelvic appendix measuring 6.5mm	30 mins	Hyperemic Appendix	None	None	yes	—	3	4	7	4	—	—	Yes	—
39	MMM499	25	M	15.1	5.8	177	14	1	Non peristaltic, non compressible tubular structure with maximum diameter of 8 mm	42 mins	Edematous and Hyperemic Appendix	None	None	yes	—	3	3	6	4	—	—	Yes	—
40	RHM956	25	M	12.6	7.4	160	18	0.8	Appendix dilated with maximum diameter of 7.8 mm with fat stranding	32 mins	Inflamed Appendix	None	None	yes	—	4	4	7	3	—	—	Yes	—
41	AHM164	28	M	16.6	6.2	223	20	0.8	10-11 mm diameter appendix	32 mins	Hyperemic Appendix	None	None	—	yes	4	6	4	5	—	Yes	—	Yes
42	VMM506	18	M	11.2	14.5	504	30.1	0.71	Appendix visualised with thickened walls and maximum diamter of 10 mm	35 mins	Inflamed and hyperemic appendix	Adhesions	None	—	yes	3	3	7	2	—		Yes	—
43	PKF286	27	F	13.2	5	198	15.7	0.76	Blind ending tubular structure with edematous walls	55 mins	Inflamed Appendix	Haemorrhage	Surgical Site Infection	—	yes	3	4	7	3	—	—	Yes	—
44	APF562	21	F	10.9	9.9	331	16	0.55	Appendicolith with maximum diameter of appendix measuring 8 mm with fat stranding	42 mins	Faecolith in the appendicular lumen	None	None	—	yes	5	3	4	6	Yes	—	—	Yes
45	BKF969	34	F	11.4	7.3	153	22	0.6	Appendix visualised with thickened and edematous walls and maximum diameter of 6 mm	48 mins	Inflamed and Hyperemic Appendix	Adhesions, Haemorrhage	Surgical Site Infection	yes	—	6	4	4	5	Yes	—	—	Yes
46	AJM125	18	M	14.5	9.6	259	20	0.68	Appendix dilated with maximum diameter of 7.8 mm with fat stranding	30 mins	Hyperemic Appendix	None	None	yes	—	4	6	3	4	—	Yes	—	—
47	SSM267	31	M	15.6	8.4	231	38	1.02	Appendix visualised of maximum diameter of 8mm with thickened walls	35 mins	Inflamed and hyperemic appendix	None	None	—	yes	6	4	5	3	Yes	—	Yes	—
48	YNF103	33	F	12	8.6	224	18	0.78	Appendix is dilated with maximum diameter of 10 mm with no evidence of fat stranding	45 mins	Inflamed Appendix, Adhesions	Adhesions	None	—	yes	3	6	3	4	—	Yes	—	—
49	MKF461	38	M	11.7	11	255	20	0.87	Appendicolith with maximum diameter of appendix measuring 10 mm	48 mins	Faecolith in the appendicular lumen	Haemorrhage	Surgical Site Infection	—	yes	6	4	7	4	Yes	—	Yes	—
50	PPF623	18	F	11	5.5	158	19	0.59	Appendix visualised of maximum diameter of 8mm with thickened walls	28 mins	Inflamed Appendix	None	None	yes	—	3	5	3	4	—	Yes	—	—
51	HKF140	35	F	11.3	5.8	207	15	0.65	Retrocaecal Appendix, dilated with 8.3 mm diameter with periappendiceal fat stranding	50 mins	Inflamed and Hyperemic Appendix	Haemorrhage	Nausea	yes	—	6	3	4	6	Yes	—	—	Yes
52	RKM344	23	M	14.1	8.1	266	24	1.01	Appendix is distended, non-compressible, measuring about 7.5mm	35 mins	Edematous and Hyperemic Appendix	None	None	yes	—	3	5	3	3	—	Yes	—	—
53	KGM306	30	M	15	8.9	367	18	0.68	Appendix visualised of 10-11mm diameter with no obvious collection.	32 mins	Inflamed Appendix	None	None	—	yes	4	4	5	3	—	—	Yes	—
54	SPF038	22	F	10.2	16.9	363	16	0.73	10-11 mm diameter appendix with fat stranding	30 mins	Edematous and Hyperemic Appendix	None	None	—	yes	4	6	4	4	—	Yes	—	—
55	RMF456	36	F	10.7	15.1	338	23	0.84	Dilated appendix with maximum diameter of 8 mm with an appendicolith	40 mins	Faecolith with Inflamed Appendix	Haemorrhage	Vomiting	yes	—	3	3	6	3	—	—	Yes	—
56	RSF289	26	F	10.8	8.5	306	25	0.7	Non compressible tubular structure with maximum diameter of 10 mm with edematous walls	35 mins	Hyperemic Appendix	None	None	yes	—	4	7	3	4	—	Yes	—	—
57	PGF081	24	F	12.3	12	186	20	0.78	Appendix visualised with thickened and edematous walls and maximum diameter of 6 mm	35 mins	Hyperemic Appendix	None	None	—	yes	4	6	4	3	—	Yes	—	—
58	SKF800	40	F	12.3	10.6	342	22	0.8	11 mm diameter appendix with fat stranding	50 mins	Inflamed and Hyperemic Appendix	Adhesions, Haemorrhage	Surgical Site Infection	yes	—	6	3	4	7	Yes	—	—	Yes
59	GBM209	23	M	12.7	6.8	180	18	0.92	Non peristaltic, non compressible tubular structure with maximum diameter of 8 mm	35 mins	Inflamed Appendix	None	None	yes	—	4	4	6	4	—	—	Yes	—
60	DAF655	19	F	11.9	7.2	234	20	0.78	10 mm diameter appendix with appendicolith	38 mins	Faecolith with Inflamed Appendix	None	None	yes	—	3	4	7	4	—	—	Yes	—
61	SBM567	25	M	15.1	10.7	240	24	0.8	Mild wall thickening pelvic appendix measuring 6.5mm	30 mins	Inflamed and hyperemic appendix	None	None	—	yes	4	6	4	3	—	Yes	—	—
62	PKM078	32	M	13.5	6.4	281	24	1.02	Non peristaltic, non compressible tubular structure with maximum diameter of 8 mm	35 mins	Inflamed and hyperemic appendix	None	None	—	yes	5	3	4	6	Yes	—	—	Yes
63	JMM661	24	M	16.4	6.9	248	19.7	0.9	Appendicolith with maximum diameter of appendix measuring 11 mm	40 mins	Faecolith in the appendicular lumen, Inflamed Appendix	None	Surgical Site Infection	yes	—	3	6	2	2	—	Yes	—	—
64	MRF981	22	F	13.9	11.8	396	12.3	0.52	Appendicolith with maximum diameter of appendix measuring 8 mm	35 mins	Faecolith with Inflamed Appendix	Adhesions	None	—	yes	4	6	2	2	—	Yes	—	—

S. No.	Demographic			Investigations					USG or CT Findings	Operation Details				Type Of PostOp Analgesia		PostOp VAS				Need For Rescue Analgesia			
	Unique Patient ID	Age	Gender	Hb	TLC	Plt	Urea	S. Creat.	Features	Duration	Operative Findings	IntraOp complications	PostOp Complications	Conventional	OR Experimental	At 6 Hrs	At 12 Hrs	At 18 Hrs	At 24 Hrs	At 6 Hrs	At 12 Hrs	At 18 Hrs	At 24 Hrs
		(yrs)	(M/F)	(g/L)	(10^3/µL)	(10^3/µL)	(mg/dL)	(mg/dL)		(in mins)	(Faecolith/Inflamed Appendix)	(Adhesions or Haemorrhage - blood loss >100 ml)		(IV Paracetamol 1gm)	(Transdermal Diclofenac 200mg)								
65	VBM876	18	M	14.2	6.2	280	17	0.99	10 mm diameter appendix with edematous walls	40 mins	Inflamed Appendix	None	None	—	yes	3	4	7	2	—	—	Yes	—
66	ZCM983	21	M	14.5	11.7	281	20.9	0.77	Appendix visualised of 8 mm diameter with fat stranding	40 mins	Inflamed and Hyperemic Appendix	Haemorrhage	Urinary Retention	yes	—	3	3	6	2	—	—	Yes	—
67	DBF015	38	F	11.7	7.7	234	10.6	0.8	Appendix visualised with thickened walls and maximum diamter of 8 mm	35 mins	Inflamed Appendix, Adhesions	Adhesions	Surgical Site Infection	—	yes	3	4	7	2	—	—	Yes	—
68	PMF739	22	F	10.5	6.2	289	26.7	0.62	Appendicolith with maximum diameter of appendix measuring 11 mm	40 mins	Faecolith with Inflamed Appendix	Haemorrhage	None	—	yes	3	3	6	2	—	—	Yes	—
69	SNM116	19	M	15.7	6.5	261	15.6	0.88	Appendix visualised with thickened and edematous walls and maximum diameter of 6 mm	35 mins	Inflamed and Hyperemic Appendix, Adhesions	Adhesions	None	yes	—	3	3	6	2	—	—	Yes	—
70	LBF277	18	F	12	13.7	356	24	0.6	Non compressible tubular structure with maximum diameter of 10 mm	35 mins	Inflamed Appendix	None	None	yes	—	3	4	6	2	—	—	Yes	—
71	SKM652	38	M	14.8	7.2	310	16.5	0.78	Appendix visualised with maximum diameter of 10 mm	30 mins	Inflamed and Hyperemic Appendix	None	Paralytic Ileus	yes	—	3	3	5	3	—	—	Yes	—
72	MBF627	23	F	12.2	7.9	264	10	0.55	Appendicolith with maximum diameter of 8 mm and edematous and thickened walls	40 mins	Faecolith with Inflamed appendix	None	Vomiting	yes	—	3	4	6	2	—	—	Yes	—
73	LTM657	40	M	14.9	13.8	342	26.2	1.06	Appendicolith with maximum diameter of appendix of 10 mm with fat stranding	45 mins	Faecolith with Inflamed appendix, Adhesions	Adhesions	Surgical Site Infection	yes	—	3	4	7	3	—	—	Yes	—
74	PSM484	18	M	14.3	8.2	259	15.9	0.92	Non compressible tubular structure with maximum diameter of 10 mm with edematous walls	40 mins	Inflamed Appendix, Adhesions	Adhesions	None	—	yes	3	5	3	3	—	Yes	—	—
75	NSM821	30	M	14.2	6.3	239	22.8	1.01	Appendix visualised of 8 mm diameter with fat stranding	30 mins	Inflamed Appendix	Haemorrhage	None	—	yes	4	7	3	2	—	Yes	—	—
76	SNF277	18	F	13.4	8.2	299	17.4	0.66	10 mm diameter appendix with periappendicular fat stranding	35 mins	Inflamed and Hyperemic Appendix	None	None	yes	—	3	4	7	2	—	—	Yes	—
77	SGF228	35	F	13.7	7.6	380	17.9	0.93	11 mm appendix with fat stranding and edematous walls	30 mins	Inflamed Appendix	None	Vomiting	—	yes	3	6	2	2	—	Yes	—	—
78	LSM287	24	M	13.5	7.8	153	12.6	0.94	Appendicolith with maximum diameter of appendix measuring 8 mm with fat stranding	55 mins	Faecolith with Inflamed Appendix with Adhesions	Haemorrhage and Adhesions	Urinary Retention	—	yes	4	8	3	2	—	Yes	—	—
79	PMF560	40	F	12.5	6.8	305	18.4	0.78	Appendix visualised of 8 mm diameter with fat stranding	40 mins	Inflamed Appendix, Adhesions	Adhesions	Paralytic Ileus	—	yes	6	4	7	4	Yes	—	Yes	—
80	SGF414	38	F	11.8	5.1	295	12.2	0.7	Non peristaltic, non compressible tubular structure with maximum diameter of 8 mm	35 mins	Inflamed and hyperemic appendix	None	Vomiting	—	yes	5	3	4	6	Yes	—	—	Yes
81	AJM490	26	M	11.5	5.4	290	14	0.72	Appendix dilated with maximum diameter of 7.8 mm with fat stranding	30 mins	Hyperemic Appendix	None	Urinary Retention	yes	—	3	3	6	2	—	—	Yes	—
82	SVF918	37	F	10	7.2	308	18.8	0.73	Blind ending tubular aperistaltic structure noted with maximum diameter of 10 mm	40 mins	Faecolith with Inflamed Appendix	Haemorrhage	None	yes	—	6	3	4	6	Yes	—	—	Yes
83	NAM995	32	M	13.3	4.8	252	16.1	0.95	Appendix visualised in retrocecal position of maximum diameter 9.3mm with thickened edematous walls	38 mins	Inflamed and Hyperemic Appendix	None	None	yes	—	4	4	6	4	—	—	Yes	—
84	KCM120	22	M	12	6.3	220	17.7	0.77	Acute Appendicitis with mesenteric lymphadenopathy	38 mins	Inflamed appendix	None	None	—	yes	3	5	3	4	—	Yes	—	—
85	RCM143	40	M	13.6	7.7	328	17.5	0.8	Appendix visualised of 10-11mm diameter with no obvious collection.	35 mins	Hyperemic Appendix	None	Urinary Retention	yes	—	6	3	4	7	Yes	—	—	Yes
86	ADM499	25	M	12.8	6.8	236	24.8	0.88	Non peristaltic, non compressible tubular structure with maximum diameter of 8 mm	30 mins	Inflamed Appendix	None	None	yes	—	3	3	5	3	—	—	Yes	—
87	SBM204	34	M	14.2	12.6	320	15.3	0.77	Retrocaecal Appendix, dilated with 8.3 mm diameter with periappendiceal fat stranding	42 mins	Inflamed and hyperemic appendix	Haemorrhage	Vomiting	—	yes	4	6	4	4	—	Yes	—	—
88	SPF715	30	F	12.6	10.7	258	15.5	0.51	Appendix visualised of 10-11mm diameter with no obvious collection.	38 mins	Hyperemic Appendix	Haemorrhage	None	yes	—	3	3	6	3	—	—	Yes	—
89	IBM228	38	M	13.2	9.4	244	27.6	1.09	Non compressible tubular structure with maximum diameter of 11 mm with edematous walls	42 mins	Hyperemic Appendix	None	Surgical Site Infection	—	yes	6	4	5	3	Yes	—	Yes	—
90	HKF721	28	F	11	10	284	14.3	0.53	Appendix dilated with maximum diameter of 7.8 mm with fat stranding	32 mins	Inflamed and hyperemic appendix	None	None	—	yes	3	6	2	3	—	Yes	—	—
91	KGM321	23	M	13.2	6.9	270	18.4	1.08	Appendix visualised with thickened walls and maximum diamter of 8 mm	40 mins	Inflamed Appendix, Adhesions	Adhesions	None	—	yes	3	5	3	4	—	Yes	—	—
92	PBF437	20	F	11.6	16.9	411	18.1	0.59	Appendicolith with maximum diameter of 8 mm and edematous and thickened walls	45 mins	Faecolith with Inflamed Appendix	None	Surgical Site Infection	—	yes	7	4	5	3	Yes	—	Yes	—
93	RTM357	38	M	15.3	12.1	319	32	1.05	10 mm diameter appendix with fat stranding	48 mins	Inflamed and Hyperemic Appendix	Haemorrhage	Urinary Retention	yes	—	6	3	4	7	Yes	—	—	Yes
94	PKF563	25	F	11.7	16.2	258	20	0.52	Non peristaltic, non compressible tubular structure with maximum diameter of 9 mm	38 mins	Inflamed Appendix, Adhesions	Adhesions	None	yes	—	7	4	5	4	Yes	—	Yes	—
95	PSM077	40	M	13.1	7.8	279	29	1.02	Appendix visualised with thickened walls and maximum diamter of 8 mm	50 mins	Inflamed and Hyperemic Appemdix	Haemorrhage	Urinary Retention	yes	—	6	3	4	6	Yes	—	—	Yes
96	MGF390	35	F	9.9	7.9	277	21	0.84	Appendix visualised of 10-11mm diameter with no obvious collection.	45 mins	Hyperemic Appendix	Haemorrhage	Nausea	—	yes	4	7	3	4	—	Yes	—	—

S. No.	Demographic			Investigations					USG or CT Findings	Operation Details				Type Of PostOp Analgesia		PostOp VAS				Need For Rescue Analgesia			
	Unique Patient ID	Age	Gender	Hb	TLC	Plt	Urea	S. Creat.	Features	Duration	Operative Findings	IntraOp complications	PostOp Complications	Conventional	OR Experimental	At 6 Hrs	At 12 Hrs	At 18 Hrs	At 24 Hrs	At 6 Hrs	At 12 Hrs	At 18 Hrs	At 24 Hrs
		(yrs)	(M/F)	(g/L)	(10^3/µL)	(10^3/µL)	(mg/dL)	(mg/dL)		(in mins)	(Faecolith/Inflamed Appendix)	(Adhesions or Haemorrhage - blood loss >100 ml)		(IV Paracetamol 1gm)	(Transdermal Diclofenac 200mg)								
97	SHM423	27	M	14.6	6.8	218	24	0.92	Appendix is distended, non-compressible, measuring about 7.5mm	40 mins	Inflamed Appendix, Adhesions	Adhesions	None	—	yes	3	6	3	4	—	Yes	—	—
98	RLF211	22	F	13.3	6.4	190	13	0.59	10 mm diameter appendix with edematous walls	38 mins	Hyperemic Appendix	None	None	—	yes	3	7	4	5	—	Yes	—	Yes
99	AKM625	21	M	12.4	7.3	214	28	1.04	Appendix visualised of 8 mm diameter with fat stranding	30 mins	Inflamed and Hyperemic Appendix	None	None	yes	—	6	3	4	4	Yes	—	—	—
100	HUM420	24	M	14.3	16	310	28	0.83	Appendix visualised with thickened and edematous walls and maximum diameter of 6 mm	35 mins	Edematous and Hyperemic Appendix	None	None	yes	—	3	5	3	4	—	Yes	—	—
101	AKM752	18	M	14.7	9.3	233	18	0.97	Mild wall thickening pelvic appendix measuring 6.5mm	45 mins	Inflamed Appendix, Adhesions	Adhesions	None	—	yes	6	4	5	4	Yes	—	Yes	—
102	RAM399	21	M	13.1	5.7	161	24	0.94	Appendicolith with maximum diameter of appendix measuring 11 mm	35 mins	Faecolith with Inflamed Appendix	None	Surgical Site Infection	—	yes	6	3	4	3	Yes	—	—	—
103	LSF253	26	F	12.5	6.9	193	15	0.82	Appendix visualised with thickened and edematous walls and maximum diameter of 6 mm	40 mins	Inflamed Appendix	Haemorrhage	None	—	yes	4	7	3	4	—	Yes	—	—
104	JMM868	32	M	13.4	13.9	447	26	0.76	Appendix visualised of 8 mm diameter with fat stranding	35 mins	Inflamed and hyperemic appendix	None	Vomiting	—	yes	4	6	3	4	—	Yes	—	—
105	SKF738	35	F	10.5	7.7	286	13	0.7	Appendix dilated with maximum diameter of 7.8 mm with fat stranding	30 mins	Inflamed and Hyperemic Appendix	None	None	yes	—	3	3	5	3	—	—	Yes	—
106	PSM458	40	M	10.8	11.3	198	24	0.74	Non compressible tubular structure with maximum diameter of 10 mm with edematous walls	38 mins	Inflamed Appendix, Adhesions	Adhesions	None	yes	—	7	4	5	4	Yes	—	Yes	—
107	VGF325	39	F	11.1	6.2	330	13	0.64	Blind ending tubular aperistaltic structure noted with maximum diameter of 10 mm	35 mins	Inflamed Appendix	None	None	yes	—	4	4	6	4	—	—	Yes	—
108	RBF884	24	F	10.8	7.9	238	20	0.56	Dilated appendix with maximum diameter of 8 mm with periappendiceal fat stranding	45 mins	Inflamed Appendix	None	None	—	yes	3	5	2	3	—	Yes	—	—
109	MSM288	30	M	13.7	9	234	28	1.01	Appendix visualised with thickened walls and maximum diamter of 11 mm	48 mins	Inflamed and hyperemic Appendix	Haemorrhage	Surgical Site Infection	yes	—	6	3	4	7	Yes	—	—	Yes
110	KSM382	18	M	16.2	7	243	16	0.93	Appendix visualised with thickened walls and maximum diamter of 10 mm	45 mins	Inflamed Appendix, Adhesions	Adhesions	None	—	yes	3	6	3	4	—	Yes	—	—
111	NBF789	23	F	12	9	312	26	0.55	8mm diameter appendix with edematous walls	30 mins	Hyperemic Appendix	None	None	yes	—	3	4	6	2	—	—	Yes	—
112	UNM264	29	M	16.3	10.4	327	17	1.02	Appendix visualised in retrocecal position of maximum diameter 9.3mm with thickened edematous walls	48 mins	Inflamed and Hyperemic Appendix	None	Nausea	yes	—	4	6	4	3	—	Yes	—	—