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Editorial
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Robotics in Total knee Arthroplasty

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The recent introduction of new robotic systems for total knee arthroplasty (TKA) has created somewhat of a craze. Nevertheless, we can ask ourselves whether it is justified to use these new but very costly technologies. The results and limitations of these robotic tools must be analyzed systematically before confirming their benefits. Most of the newest robotic systems are interactive ones. The term "robotic surgery" refers to the use of programmable devices to perform a wide variety of surgical tasks. These are not intended to replace the surgeon but rather to provide assistance. This activity reviews the role of the interprofessional team in evaluation and treatment using robotic assistance to perform knee arthroplasty. (1)

Keywords: Robotic surgery, Total knee arthroplasty (TKA), Curexo Technology

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Robots present a tool in which surgeons can do surgical procedures while minimizing human error and maximizing operative accuracy. The term 'robot' begins from Czech word 'robota,' which means forced labor or activity. In 1920, Karel Capek, Czech play writer, wrote a science fiction play called " Rossum's Universal Robots," where Robots were a series of factory-manufactured artificial people that undertook ordinary tasks for their human masters. The play premiered on 25th of January 1921, and that is when word "robot" was introduced to English language and to science fiction as a whole. The first robot surgery ever was performed in 1988 to perform neurosurgical biopsies. Since then, applicability of robotics in surgery has progressed remarkably. Besides the rapidly increasing needs for TKA in past years, robotic total knee arthroplasty (TKA) has increased in number considerably. (1)

In orthopedics, a robotic TKR is designed to decrease mistakes associated with bone cuts and prosthesis position and alignment. Robotic TKR has better surgical and clinical patient outcomes than conventional TKR.[2] The first robotic-assisted TKA was performed in 1988 in United Kingdom.[3] Robotic TKR uses a preoperative CT scan to create a 3D reconstruction of original knee. This patient model is then used to calculate measurement of femoral and tibial bone resection and select exact size of implant.[4]

The aim of TKA is to restore the mechanical axis, restore the joint line, restore balance in flexion and extension gaps, and restore the Q angle for perfect patella tracking. To reach these goals, the preservation of the surrounding soft-tissue is crucial. Destruction of the collateral ligaments, PCL, or extensor mechanism may lead to delay in the recovery, decrease joint stability, and decrease prosthesis life. Robotic TKA limits saw action, which reduces iatrogenic bone and soft-tissue damage.[5][6]

Robotic total knee arthroplasty uses certain software to convert anatomical images into a virtual three-dimension reconstruction of joints. The anatomy is usually obtained by requesting pre-operative CT or intraoperative tibia and femur mapping. The surgeons use this model to plan the perfect bone cut, implant positioning, limb alignment, and bone coverage based on the patient's anatomy. The intraoperative robotic device helps to minimize iatrogenic soft-tissue and bony injury. [7][8]

Robotic TKR was developed to improve bone preparation accuracy and decrease the possibility of outliers to guarantee a longer prosthesis lifespan. Adequate restoration of the mechanical axis in TKA is associated with a decrease in polyethylene wear and a lower revision arthroplasty rate.[9][10][11]

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There are different types of robotic knee arthroplasty. Certain types actively do all steps of tibial and femoral bone resections, known as "fully active. Other types enable the surgeons to do the surgery while giving feedback intraoperatively to assist in control resection of the tibia and femur to the pre-operative surgical plan, and this group is known as "semi-active." The surgeon makes the approach, puts the retractors to protect the soft tissues.

New robotic systems such as the Navio PFS (Blue Belt Technologies, Plymouth, MN, USA), Mako (Mako Stryker, Fort Lauderdale, FL, USA), Rosa (Zimmer-Biomet, Warsaw, Indiana, USA) and iBlock (OMNIlife Science, East Taunton, MA, USA) were developed that are being used more and more. (12) Various classification systems have been proposed to characterize the different designs of robotic technology used in medicine. The most well-known is the one proposed by Schneider and Troccaz in 2001 [13].

It places robotic systems in four categories: passive, active, interactive, and tele-operated passive systems consist of an articulated arm that holds an instrument moved manually by the surgeon, with the instrument's position being recognized by the navigation system. They do not directly participate in carrying out the procedure, which remains completely under the surgeon's control. The OMNI® robot fits in this group. Conventional navigation systems used for TKA are often integrated into this type of system.

Active systems are robots that use preoperative and intraoperative planning data to perform multiplanar surgical manipulations autonomously (without the surgeon's participation). The Robodoc® fits into this group. interactive systems are robots that require an interaction between the robot and the surgeon who constrains the robot. There are two types of strategies in this group: semi-active and synergistic systems.

In semi-active systems, this mechanical constraint can be summarized as a movement without feedback to the surgeon. Conversely, for synergistic systems, the mechanical constraints are programmable: these newer systems are based on the principle of haptic models (i.e. information feedback) with the robot generating forces where the amplitude and frequency reproduce true sensations (touch, vision). Lastly, teleoperated systems correspond to robots that are controlled remotely by a surgeon. The most well-known example is the DaVINCI® robot.

Developed in 1986, Robodoc (Curexo Technology, Sacramento, CA, USA) was the first system with ORTHODOC (robotic arm and software) to be used for joint replacement surgery [15], [16] (Fig. 2). It is currently sold under the name TSolution-One (Think Surgical Inc, Fremont, CA, USA; previously Curexo Technology). This is an autonomous active system (without surgeon interaction) based on preoperative CT scan images with an open platform (i.e. suitable for all implants) [14], [17]. The iBlock robotic cutting guide (OMNIlife Science, Raynham, MA, USA), which was previously called Praxiteles, was approved by the Food and Drug Administration (FDA) in 2010 to assist with TKA implantation [14].

This is a motorized cutting guide that only helps the surgeon make the femoral bone cuts based on a preoperative plan and avoids errors associated with using a standard oscillating saw blade. The main advantage of this system is that no CT scan is needed. Conversely, it operates as a closed platform, thus can only be used with one specific type of knee implant and does not provide gap balancing. [14]

The Navio PFS, developed by Blue Belt Technologies and currently distributed by Smith & Nephew (Watford, UK), is a robotic reamer controlled manually by the surgeon [14]. First approved in 2012 by the FDA for partial knee replacement, it is now available for total joint replacement. To our knowledge, no studies on this system have been published. This is another semi-active system that follows the reamer's trajectory in the navigation field. It controls the reamer's rotation speed and its extension (or retraction) from its sleeve which allow the resections to be done as planned. (18,19)

The Mako Robotic Arm Interactive System was initially developed by Mako Surgical Corporation and is now sold by Stryker Orthopaedics (Mahwah, NJ, USA) (Fig. 5). It was approved by the FDA in 2016. This system consists of a robotic arm that helps with TKA implantation using a haptic interface. This semi-active robot stops the saw when it goes beyond the cut defined in the preoperative plan; thus, it improves a surgeon's ability to restore the knee's alignment and to protect the soft tissues [20], [21], [22].

The Rosa Knee robot was developed by Zimmer-Biomet (Warsaw, IN, USA) in collaboration with MedTech (Montpellier, France) and was approved by the FDA in January 2019. This system is an interactive robotic platform where the robotic arm allows the cutting guides to be positioned based on intraoperative plan obtained using navigation data. This is an imageless system, like the Navio robot, that can be supplemented with preoperative radiographs to create a 3D model of the patient's knee using an atlas (X-Atlas™). This step can be used to deform the 3D knee model using certain prominent points determined on the patient's radiographs. The pitfall of this technology is the modelling precision in patients whose anatomy is outside the norms (post-traumatic malunion, fracture fixation devices in place, major dysplasia, etc.). Since this system is very new, no published studies exist on it. (22) In summary, given their cost, diffusion of these new technologies will be limited to high-volume surgical facilities, use of these new technologies requires that we define patient-specific surgical strategies based on big data analysis.

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Overview Article
Orthopaedic Research
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The Current Status of Indian Orthopaedic Research: A Comprehensive Overview

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This overview illuminates the significant evolution of Indian orthopaedic research from 1996 to 2023, showcasing exponential growth in publications and an increasing global presence. The study reveals a remarkable annual growth rate of 20.8% in literature, with predominant contributions from leading institutions. Despite the surge in quantity, the research underscores the imperative enhancement required in the quality of publications, with only a minor fraction gaining substantial citations. Highlighting the role of international collaborations, particularly with the USA and UK, the overview articulates how these partnerships have been pivotal in elevating the research quality and impact. The narrative also addresses the diverse range of topics covered by Indian researchers in international journals, emphasizing significant scientific contributions in areas like joint replacement, sports medicine, and fracture research. The study acknowledges the regional distribution of contributions across India, signalling a call for increased research emphasis in underrepresented areas. Looking forward, the overview accentuates the potential of Indian orthopaedic research, advocating for enhanced funding, infrastructure, and global collaboration to address prevailing challenges and leverage technological advancements for the betterment of patient care and health equity.

Keywords: Indian orthopaedic research, publication growth, international collaborations, research quality, global impact, futuristic directions

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Introduction

The landscape of orthopaedic research in India has undergone a remarkable transformation in recent years. With a burgeoning population and a rising incidence of musculoskeletal conditions, the country has emerged as a significant player in the global orthopaedic research arena, a feat that is both impressive and a source of pride.

Growth and Development

In a bibliometric study of Indian Orthopaedic research between 2002 and 2021, 4606 publications were found with an annual growth rate of 20.8%. The premier institutions like AIIMS-New Delhi and PGIMER-Chandigarh produced a more significant proportion of articles (5.2% and 4.3%), and R. Vaishya and S. Rajasekaran were the most productive authors, contributing 1.6% and 1.1% share of publications respectively **[1].** Indian orthopaedic research has witnessed exponential growth since 1996, with only 22 publications to 972 publications in 2023 **(Figure 1) [2].** It is driven by several factors, like the increasing prevalence of orthopaedic diseases, coupled with the establishment of specialized research institutions and centres, has created a conducive environment for research. Increased funding for research projects and scholarships has also played a crucial role in fostering a research-oriented culture **[3].**

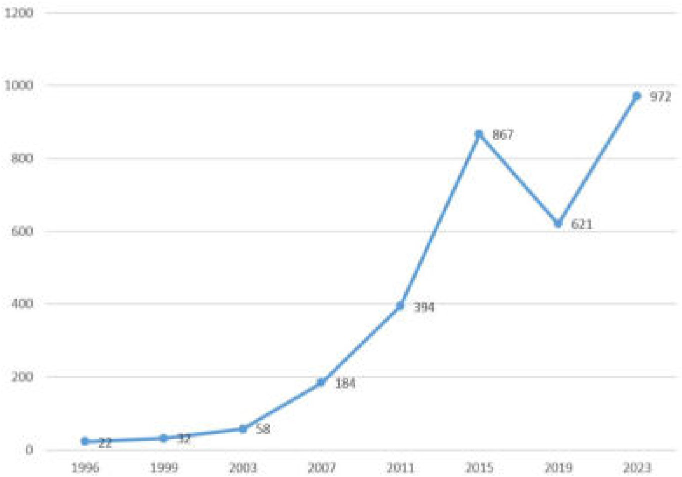

Figure 1: Indian Orthopaedic publications from 1996 to 2023, showing an increasing trend, especially since 2011. (Source: SCIMAGO [2])

However, the quality of Indian research needs to be boosted. A study found that only 179 (3.88%) of all the Indian publications received more than 50 citations in the last two decades, with an average Citations Per Paper (CPP) of 127.2 **[4].** Collaborations with international institutions have significantly enhanced the quality and impact of Indian orthopaedic research. The USA and UK (31.8% and 21.3%) represented the highest collaborative share with Indian authors in a study **[1].** Joint research projects, exchange programs, and knowledge sharing have facilitated the transfer of expertise and technology, enabling Indian researchers to stay at the forefront of global advancements.

Indian orthopaedic research has made substantial contributions to the global knowledge base. Indian researchers have published numerous high-quality studies in prestigious international journals, addressing a wide range of topics such as joint replacement **[5],** sports medicine **[6,7],** and fractures **[8]**.

Scientometric analysis of Indian Orthopaedic research in some sub-specialities has also been done recently. In Arthroplasty, 872 publications were found from 2002-2021, with a 1.36% share of global output [**5**]. In contrast, in arthroscopy, 632 publications were found between 1994 and 2020 **[6,7],** and in fracture research, 1046 publications were found between 1989 and 2022, with an average CPP of 8.5 [**8].**

In a study, Indian Orthopaedic publications between 2009 and 2020 were maximum from the states of Tamil Nadu (n=4503), followed by Delhi (n=3480), Maharashtra (n=2588), Karnataka (n=1877) and West Bengal (n=1329), with similar contributions from the Government (n=1459) and Private (n=1225) institutions **[9].**

It is to be noted that the state of Madhya Pradesh did not appear on the list of the top 10 contributing Indian states. Hence, more emphasis on research and publications is needed here as this state now has about 30 medical colleges and many orthopaedic postgraduates and practising orthopaedic surgeons.

Current Global Standing

An increasing trend in publications in Orthopaedics and Sports Medicine was reported from across the globe, with some Asian countries like China and India showing substantial growth **[10].**

In Asia, India ranks fourth in 2023, after China, Japan and South Korea, with a total of 10333 publications from 1996 to 2023, with an average of 9.34 citations per publication **[3].** India's global ranking in Orthopaedics and Sports Medicine is at 16th position in 2023, which has improved from 32nd in 1996 **[2].**

Future Directions

Despite its significant progress, Indian orthopaedic research still faces several challenges, including limited funding for research, inadequate infrastructure, and a shortage of skilled researchers. To address these issues, investing in research infrastructure, providing adequate funding, and fostering a conducive research environment is imperative.

Future directions for Indian orthopaedic research (**Figure 2)** are filled with promise and potential. A focus on translational research, collaboration with industry, and the use of technological advancements can revolutionize orthopaedic research and patient care. Furthermore, prioritizing research on conditions that disproportionately affect underserved populations can help improve health equity, offering a hopeful outlook for the future of Indian orthopaedic research.

Figure 2: Future Research Directions Suggested for Indian Orthopaedic Community

Conclusion

Indian orthopaedic research has grown remarkably and significantly contributed to the global scientific community. By addressing the existing challenges and capitalizing on future opportunities, India can further strengthen its position as a leading force in orthopaedic research and improve the lives of millions of people worldwide

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Complications of uncemented total hip replacement in avascular necrosis head of femur, encountered intra and post-operative period

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DOI:Total hip replacement

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Introduction: Avascular Necrosis Head of Femur is a progressive disorder in which lack of sufficient blood supply leads to cell death, fracture and collapse of the affected area. In stage 3 and 4 patients of AVN of hip, uncemented total hip replacement is the treatment of Choice. The complications in uncemented THR can be intraoperative, postoperative and anaesthetic and also according to time duration can be immediate, early and late.

Material and Method: Fifty-one patients of Avascular necrosis of femoral head of stage III and IV, are operated in last two years by uncemented total hip arthroplasty and their results were assessed by Harris hip score. There are few complications which we encountered in intraoperative and post operative period. The assessment and corresponding solutions of the complications are provided in this study.

Results: The pre-operative modified harris hip score had a mean of 48.51 with a standard deviation of 3.114. The post-operative modified harris hip score increased significantly to a mean of 90.96 with a standard deviation of 3.268. Intraoperative complication like periprosthetic fracture was seen in 3.9% cases only. The majority (92.2%) did not experience any anesthetic complications. Among those who did, 3.9% encountered hypotension and tachycardia, while 2% experienced postoperative nausea and vomiting. Additionally, one patient (2%) suffered from a spinal headache (PDPH). Post-operative complications were present i.e. 5.9% of the patients experienced sciatic nerve injury, and another 5.9% had superficial infections. Additionally, anterior thigh pain, deep infection, and limb length discrepancy each affected 3.9% of the patients, while 2% experienced dislocation.

Conclusion: Uncemented THR is one of the most successful operative procedure done across the globe. The best possible outcome in uncemented total hip replacement surgery can be achieved by appropriate patient selection, appropriate implant size and design, and above all maintaining sterility intra-operatively and during regular dressings and during suture removal.

Keywords: Uncemented THR, AVN Hip, Complications

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Introduction

Avascular Necrosis Head of Femur is a progressive disorder in which lack of sufficient blood supply leads to cell death, fracture and collapse of the affected area.[1]

Etiologic factors associated with osteonecrosis are such as idiopathic, corticosteroid administration, alcohol use, SLE, Cushing disease, chronic renal failure/hemodialysis, pancreatitis, pregnancy, hyperlipidemia, organ transplantation, intravascular coagulation, thrombophlebitis, cigarette smoking, hyperuricemia/gout, AIDS, femoral neck fracture, dislocation or fracture-dislocation, sickle cell disease, hemoglobinopathies, caisson disease (dysbarism), gaucher disease and radiation. [2]

Avascular Necrosis of Head of Femur is classified into stages by Ficat and Arlet Classification into 5 stages – Stage 0,1,2,3,4 on basis of symptoms, radiological changes, bone scan, pathologic findings, biopsy. For stage 0,1,2 patient is advised for non-operative management with avoidance of associated etiologic factor if any and core decompression and/or bone grafting. In case Stage 3,4 patient is advised for operative management i.e. uncemented total hip replacement is the treatment of choice.

Materials and method

The study was carried out on 51 Patients of AVN Head of Femur operated by uncemented total hip replacement in the department of orthopedics, R. D. Gardi Medical College, Ujjain. This study is done from August 2022 to June 2024. Information on the patients was compiled from clinical details, case files and operation theatre records. Study type was observational study. Objective of this study was to assess the complications occurred during or after uncemented THR.

Inclusion Criteria was, all the patients of Stage 3,4 avascular necrosis of femoral head, patients of age group more than 18 years and less than 70 years**,** willing to give informed consent**,** with minimum follow-up period of 6 months Exclusion Criteria was patients with deformities or pathologies in other lower limb joints that could negatively affect the functional outcome of the surgery**,** patients younger than 18 years or older than 70 years, who were lost to follow-up or uncooperative, who refused to consent to the study.

Case 1:

Figure 1 and 2: pre-operative x-ray and post-operative xray

Figure 3: A, B, C, D -Post-op follow up images after 1 month

Results

In the current study 51 patients were studied. Mean age of the patients studied were 40.88 ± 14.20 years. Median age 38 years, minimum age 22 and maximum age 70 years. Majority of patients were in the <40 years age group, accounting for 62.7% of the participants. There were more male patients (72.5%) than female patients (27.5%). In causes of AVN head of femur, the most common cause was idiopathic in 74.5% cases, steroid induced in 23.5% and traumatic only in 2% cases only.

Housewives had the highest complication rate (66.7%), significantly more than laborers (18.9%) and students (0.0%), with a p-value of 0.005, indicating a statistically significant difference. A vast majority (94%) had no limb length discrepancy before the operation, while only 1.96% (1 patient) had a discrepancy (shortening) of 1 cm and 1.96 (1 patient) had a discrepancy (shortening) of 1.5 cm and 1.96 (1 patient) had a discrepancy (lengthening) of 1.5 cm. After the operation, 96.1% of the patients had no limb length discrepancy, similar to the preoperative status.

However, 2% of the patients had a discrepancy (shortening) of 1.5 cm, and another 2% had a discrepancy (lengthening) of 1.5 cm. This indicates that postoperative limb length discrepancy remained minimal, with only a small number of patients experiencing a noticeable difference.

The vast majority (96.1%) did not experience any intraoperative complications, while only 3.9% encountered periprosthetic fractures during surgery. This suggests that intraoperative complications were relatively rare in this patient population undergoing hip surgery.

The majority (92.2%) did not experience any anesthetic complications. Among those who did, 3.9% encountered hypotension and tachycardia, while 2% experienced postoperative nausea and vomiting. Additionally, one patient (2%) suffered from a spinal headache (PDPH). This indicates that while most patients did not face anesthetic complications, a small percentage experienced various issues related to anesthesia administration. The majority of patients (74.5%) did not experience any complications after surgery. However, 5.9% of the patients experienced sciatic nerve injury, and another 5.9% had superficial infections.

Additionally, anterior thigh pain, deep infection, and limb length discrepancy each affected 3.9% of the patients, while 2% experienced dislocation. The pre-operative Modified Harris Hip Score had a mean of 48.51 with a standard deviation of 3.114, while the post-operative score increased significantly to a mean of 90.96 with a standard deviation of 3.268. The paired t-test for the difference between pre-operative and post- operative scores showed a mean difference of 42.451, with a 95% confidence interval ranging from 41.316 to 43.586, and a p-value less than 0.0001, indicating a highly significant improvement in hip function post-surgery.

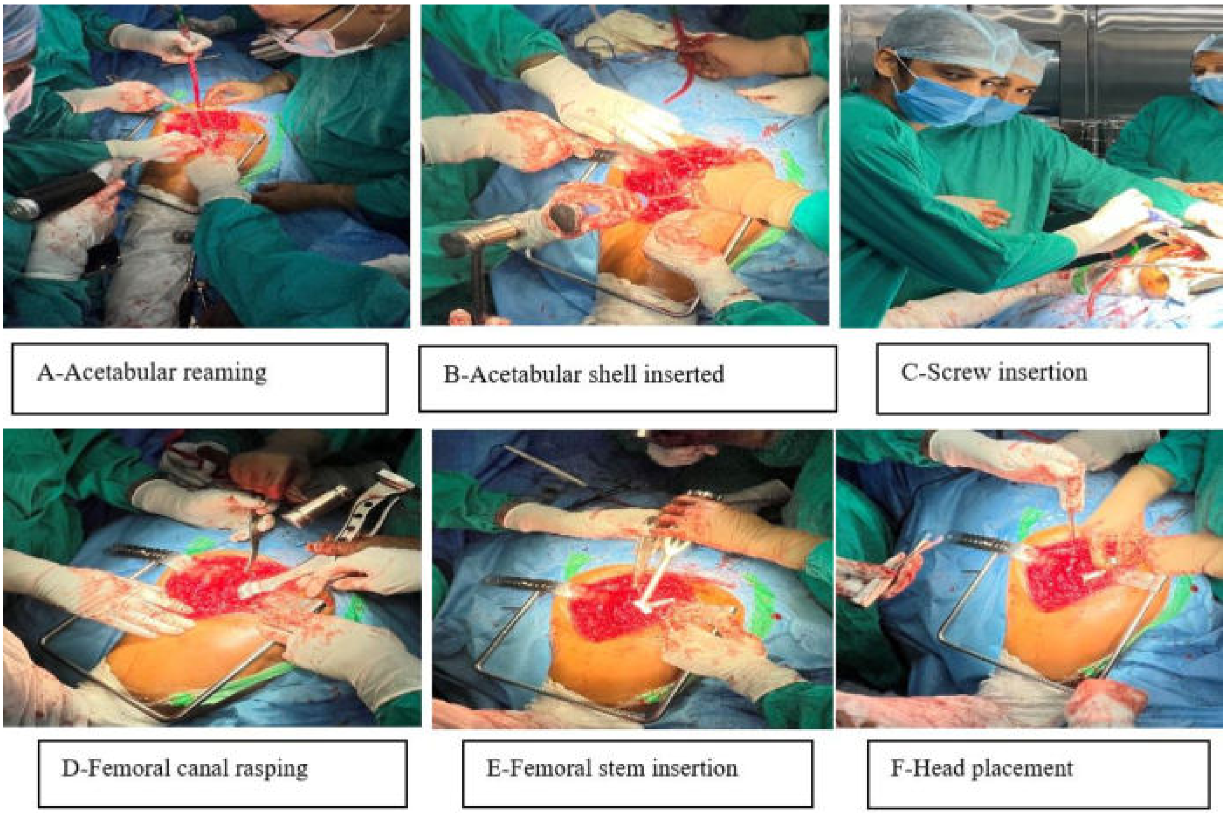

Figure 4: A, B, C, D, E and F: Intraoperative images

Complications apart from being anaesthetic, intra-operative, post- operative, are also divided into immediate, early, and late as per the time duration. CImmediate complications occur within hours to days after surgery.

Early complications occur within weeks to months after surgery. Complications that arise months to years after surgery are considered late complications. Immediate / perioperative complications are anaesthetic Complications which include hypotension & tachycardia, post-op nausea & vomiting, Spinal headache (PDPH).

Nerve Injury includes sciatic nerve injury chiefly, which gives rise to foot drop. Also includes femoral and obturator nerve injury as well. In vascular Injury, **t**he external iliac and femoral arteries are the vessels most commonly at risk during this procedure. The risk of direct laceration or rupture increases with drill or screw penetration during acetabular implant fixation.

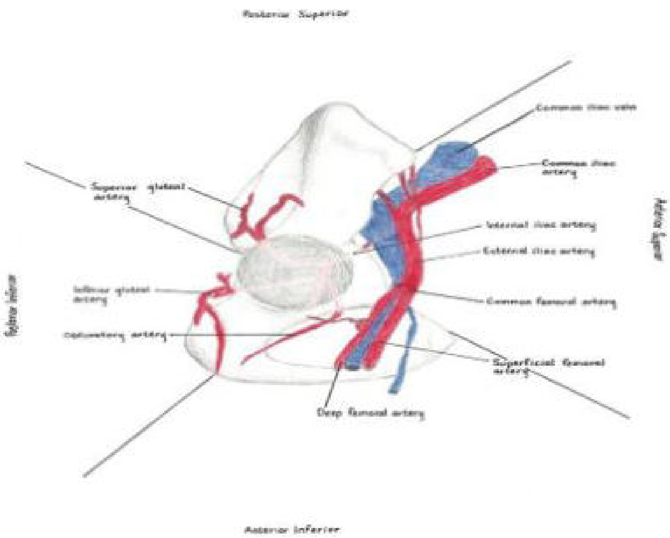

Figure 5: Hip Vasculature and Corresponding quadrants of acetabulum, postero-superior quadrant is the safest 4

Periprosthetic fractures are fractures that occur around orthopedic implants. 5

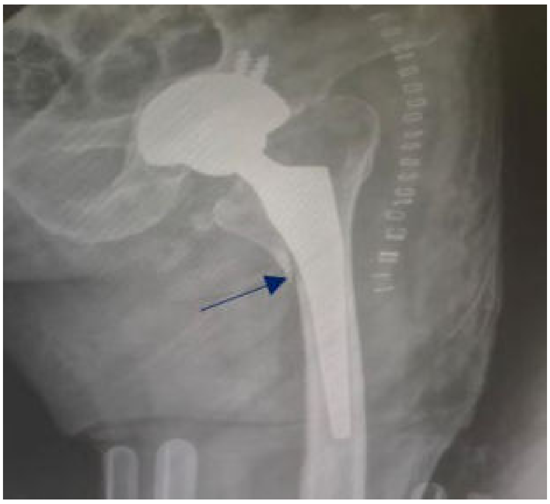

Figure 6: Intra operative Periprosthetic fracture

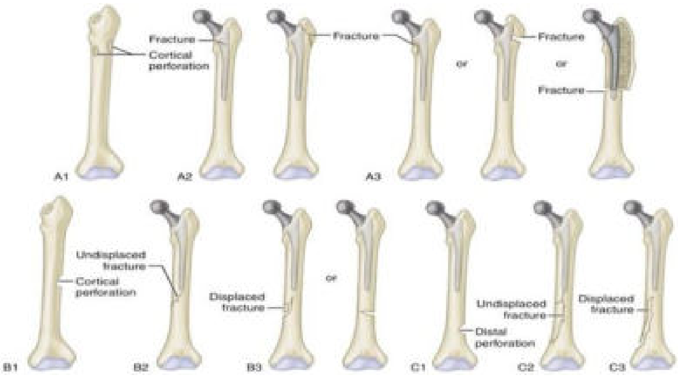

Figure 7: Vancouver classification for Periprosthetic Hip Fractures 6

Venous thromboembolism (VTE), encompassing both deep venous thrombosis (DVT) and pulmonary embolism (PE), is a significant complication following total hip arthroplasty (THA). Deep vein thrombosis (DVT) commonly manifests with symptoms such as pain, swelling, warmth, or erythema in affected limb, usually in lower extremities, although it can also occur in upper extremities. 7 Early complications are infection, dislocation and limb length discrepancy. The standard management of infected THA involves removal of implant, thorough debridement, and administration of antibiotics both systemically and locally through impregnated spacers.

Figure 8: Infected THR

Dislocations can be classified based on the direction of dislocation, each associated with specific mechanical causes. First is cranial dislocation that can result from excessive cup inclination, abductor insufficiency, or polyethylene wear, causing dislocation with the hip joint adducted and extended. Second is posterior dislocation arises due to insufficient anteversion or retroversion of the cup, joint hyperlaxity, or primary or secondary impingement can cause posterior dislocation, characterized by dislocation with internal rotation and adduction of the flexed hip joint or deep flexion. Third is anterior dislocation it results from excessive combined antetorsion of the stem and cup, joint hyperlaxity, or primary or secondary impingement, leading to external rotation and adduction of the extended hip.

Figure 9: Radiological Picture of Posterior Dislocation in Uncemented THR

Limb length discrepancy (LLD) is a common complication post-THA, with reported incidence rates varying widely from 1% to 50%.9 Lengthening of the operated limb is more frequently observed than shortening.**10** LLD can be measured by comparing the distance from the antero- superior iliac spine to the medial malleolus on both sides. **11**

Figure 10: Pre And Post-Operative Clinical Image Of Uncemented THR Showing Limb Length Discrepancy

Late complications are chronic thigh pain, heterotopic ossification, osteolysis and loosening of implant.

Anterior thigh pain is a recognized complication following uncemented primary total hip replacement, with reported incidence rates varying from 1.9% to 40.4%. The predominant cause of pain in most cases is loosening of the implant, typically localized to the anterolateral aspect of the mid-thigh at the level of the stem tip.

Heterotopic ossification (HO) presents a spectrum from faint, indistinct formations around the hip to complete ankylosis,[12] impacting postoperative outcomes in total hip arthroplasty (THA). Prophylaxis typically includes low-dose radiation and non-steroidal anti-inflammatory drugs (NSAIDs). Surgical excision is seldom necessary due to mild associated pain and the complexity of extensive exposure required for excision.

Osteolysis is characterized by progressive periprosthetic bone destruction, evident on serial radiographs by developing radiolucent lines or cavities at the implant-bone interface.[13] The primary mechanism involves an immunological response to particulate debris, triggering macrophage-mediated bone resorption and subsequent implant loosening.[14]

Aseptic loosening, defined as the failure of prosthetic component fixation without infection, is a significant concern in total hip arthroplasty (THA). This condition may arise from inadequate initial fixation, mechanical loss of fixation over time, or biologic loss of fixation due to particulate-induced osteolysis surrounding the implant. [15]

Discussion

This study was conducted to assess the complications of uncemented total hip replacement (THR) performed at our institution, specifically in patients with avascular necrosis (AVN) of the femoral head. The 20th Annual Report of the National Joint Registry [16] of England and Wales, Northern Ireland, the Isle of Man, and Guernsey reveals that uncemented and hybrid total hip replacements currently represent the predominant methods, accounting for 76.5% of all primary hip replacements performed in 2022. The proportion of cemented hip replacements has decreased by half to 19.1% between 2006 and 2022.

The New Zealand Joint Registry[17] analysis shows that out of 42,665 primary total hip replacements (THRs) documented, 920 cases (2.16%) required revision involving replacement of at least one component. Fully-cemented THRs exhibited a lower overall revision rate ($p < 0.001$), whereas uncemented THRs had a lower rate among patients under 65 years of age ($p < 0.01$).

Swedish Hip Arthroplasty Register 2023 [18] conducted in a total of 20,568 primary total hip replacements were reported., states that uncemented fixation has been on the rise in the past two decades. In 2003, uncemented replacements constituted only 5 % of all reported operations, but in 2022, this figure exceeded 33%. The current study found that mean age of patients was 40.88 ± 14.201 years, with majority (62.7%) in under 40 years age group, followed by 27.5% in 40-60 years group, and 9.8% in over 60 years group. This age distribution highlights a significant prevalence of hip issues in younger to middle-aged adults.In comparison, studies conducted by Kakaria HL et al.[19] and Karimi S et al.[20] also noted a higher incidence of hip joint issues among middle-aged individuals.

The study revealed that 62.7% of the patients did not report any addictions, while 43.1% were smokers, 31.3% consumed alcohol, and 7.8% chewed tobacco. Karimi S et al. emphasized the harmful effects of smoking and alcohol consumption on bone health and vascular integrity, which can worsen conditions such as AVN. Smoking is known to reduce bone mineral density and restrict blood flow to the femoral head, thereby increasing susceptibility to AVN and other degenerative joint disorders.

In our study several complications were reported associated with hip procedures, including infection (5 cases, 9.8%), dislocation (1 case, 2%), sciatic nerve injury (3 cases, 5.9%), and heterotopic ossification (not specifically mentioned but inferred from related literature). These complications were in line with findings from previous studies, although the rates varied.

In our study, the most common postoperative complications included superficial infection (3 cases, 5.9%), deep infection (2 cases, 3.9%), and anterior thigh pain (2 cases, 3.9%). Limb length discrepancy was observed in 2 cases (3.9%). These findings emphasize the importance of meticulous surgical technique and vigilant postoperative care to minimize these adverse outcomes.

Schmalzried et al. [21] conducted a study involving 3,126 consecutive total hip replacements, identifying postoperative neuropathy in the ipsilateral lower extremity in fifty-three cases (1.7%). The prevalence was 1.3% after primary arthroplasties but rose to 5.2% for those performed due to congenital dislocation or dysplasia of the hip and 3.2% after revision surgeries, indicating these operations were significant risk factors ($p < 0.01$).

A study conducted by Patsiogiannis et al. [22] , concluded that certain B1 fractures will benefit from revision surgery, whilst some B2 fractures can be effectively managed with osteosynthesis, especially in frail patients.

A meta-analysis by Peng et al. [23] examined the use of topical vancomycin powder to prevent surgical site infections in primary total hip and knee arthroplasty. The study found that the local application of vancomycin powder significantly reduced the rates of surgical site infections (SSIs) and periprosthetic joint infections (PJI) in primary total joint arthroplasty (TJA) without altering the bacterial spectrum involved.

A Study conducted by Rao et al. [24] , in 98 patients who underwent arthroplasty using the posterior approach wore a knee immobilizer postoperatively When the posterior approach is used in hip replacement procedures, we have found that postoperative use of a knee immobilizer helps prevent dislocation.

A Study done by Gordon et al. [25] reported that approximately 90% of the population has a limb length discrepancy of less than 1.0 cm. Hip pathology is more often associated with the longer leg, while knee issues have been observed in both the longer and shorter legs in various studies. Low back problems are more common on the short side in individuals with limb length discrepancies.

The average preoperative HHS improved from 48.51 ± 3.114 to 90.96 ± 3.268 postoperatively, highlighting a significant enhancement in patient quality of life. Initially, all patients had poor HHS scores, but after surgery, 29.4% achieved a "Good" score, and 70.6% attained an "Excellent" score. Similar improvements in HHS have been documented in studies by Kakaria HL et al. and Karimi S et al. Kakaria HL et al. reported an increase in HHS from an average preoperative score of 43 to 89 postoperatively, while Karimi S et al. noted that 90% of their patients achieved a perfect HHS of 100%, with 97% showing excellent results on a modified HHS. These findings are in line with the outcomes observed in the present study, underscoring the efficacy of hip procedures in enhancing patient outcomes.

Morshed et al.[26], in their systematic review and meta-analysis of 20 articles comparing cemented versus uncemented fixation in 112,094 total hip arthroplasty (THA) cases across 24 studies, did not find a clear advantage for either procedure when defining failure as the need for revision of one or both components or revision of a specific component.

In a meta-analysis conducted by Fei et al. [27], which investigated the relationship between the use of screws and acetabular cup stability in total hip arthroplasty, seven trials involving 1402 patients (1469 THAs) were included: 767 patients (809 THAs) with screws and 635 patients (660 THAs) without screws. The findings indicated that uncemented acetabular component fixation with the use of additional screws was not associated with cup migration, migration on roentgen stereophotogrammetry, or reoperation rates after THA.

A systematic review and meta-analysis of randomized controlled trials comparing cemented versus uncemented total hip replacement (THR), conducted by Abdulkarim et al. [28], analyzed a total of 930 THRs performed in 778 patients. The study revealed that cemented and uncemented THRs showed comparable implant survival rates based on revision rates. Nevertheless, cemented fixation demonstrated superior short-term clinical outcomes, notably in terms of pain relief.

According to Tian et al. (29) meta-analysis on partial versus early full weight bearing following uncemented total hip arthroplasty (THA), early full weight bearing appears to be safe and does not lead to an increased incidence of postoperative complications.

Conclusion

Uncemented THR is one of the most successful operative procedure done across the globe. Still, it is has got complications associated with it.

Any sort of complication occurring to patient of uncemented total hip replacement is worst and dreaded outcome, orthopaedic surgeon tries his best to avoid it. The best possible outcome in uncemented total hip replacement surgery can be achieved by appropriate patient selection, appropriate implant size and design, and above all maintaining sterility intra-operatively and during regular dressings and during suture removal. Current scenario indicates that due to increased steroid medication and addiction avascular necrosis of head of femur cases will increase causing increase in uncemented total hip replacements as an operative procedure.

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Periprosthetic femoral fracture around the stem of Total Hip Arthroplasty

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Introduction: Fractures occurring over a hip femoral implant can be divided into intra-operative and post-operative PFFs, and their treatment depends on factors that may severely affect the outcome: level of fracture, implant stability, quality of bone stock, patient's functional demand, age and comorbidities, and surgeon expertise. Here, we are discussing the results of management of periprosthetic femoral fractures.

Material and method: Eleven patients of periprosthetic femoral fractures were operated in our hospital in last 3 years. Patients were followed up regularly. Their results were assessed by modified harris hip score. Two fractures were Type A, seven cases were type B and one case was type C fractures. Type A fractures were managed by cables and stainless-steel wires. Type B fractures were managed by long plates, and type C fracture was managed by distal femoral locking plate.

Results: Results were assessed by modified harris hip score. It was found excellent in 3 cases, good in 7 cases and fair in one patient.

Conclusion: In the presence of a well-fixed stem there are various options for retaining the implant and reduction and fixation of the fracture, but loose implants require revision arthroplasty and internal fixation. Future large-scale randomised trials are needed to determine the optimum fixation option with an aim to reduce these complications.

Keywords: Total hip arthroplasty, periprosthetic femoral fractures, Vancouver classification

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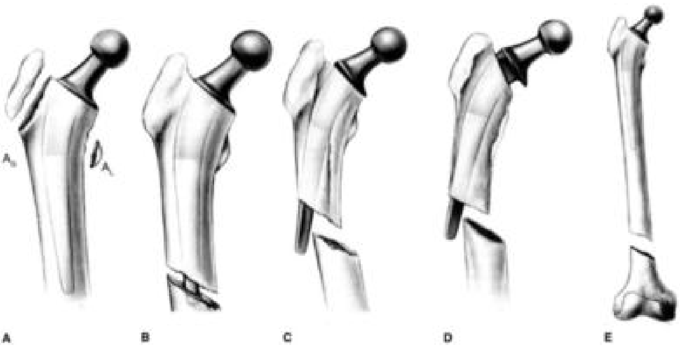
Introduction

Periprosthetic femoral fracture is a difficult surgical problem for orthopedic surgeons. It can happen during or after the operation. The ever-expanding indications for total hip arthroplasty are leading to more implants being placed in younger as well as in older patients with high functional demand. Also, prolonged life expectancy is contributing to an overall increment of periprosthetic femoral fractures. The incidence of periprosthetic femoral fractures (PFFs) has been reported to be between 1% and 11% over a primary and up to 18% over a revised hip femoral stem (1). Management of these injuries is often resource intensive and can present significant socioeconomic challenges. Understanding the principles of surgical management these cases and recognising when fixation or replacement is required is critical (2). Risk Factors for periprosthetic femoral fractures are osteoporosis, poor bone stock, uncemented femoral stem, revision of a femoral stem, previous fracture neck of femur treated by THR, osteolysis and aseptic loosening. These fractures can occur during previous implant removal, bone preparation and placement of the revision implant. History and physical examination reveal acute onset of pain, deformity and history of a fall. PFFs occurring over a THA can be divided into intra-operative and post-operative PFFs. Intra-operative fractures are estimated to occur in less than 1% of cemented and in 5.4% of uncemented primary THA, while in revision surgery the incidence of PFFs is higher, up to 3.6% during cemented and 20.9% during uncemented procedures. (7)

In general, in the context of a well-fixed femoral stem (Vancouver B1 or C) it is possible to retain the prosthesis and treat with internal fixation methods (8). When there is concern of loosening or instability around the stem (Vancouver B2, B3) then the literature supports revision arthroplasty surgery with or without internal fixation (9).

Radiographic Evaluation is done by full-length views of the femur (AP, lateral view), AP pelvic radiograph. Judet views are done to evaluate the floor, roof, and columns of the acetabulum. CT and MRI are done to rule out unusual complexity, especially around the acetabulum. Evaluation is done to exclude the possibility of infection by Inflammatory markers and intraoperative testing is done by frozen section analysis of periprosthetic tissue. Classification of periprosthetic femoral fracture is Vancouver classification. This system is based on site of the fracture, stability of the stem and quality of bone.



Type A fractures involve the greater or lesser trochanter, type B are diaphyseal starting around the stem and may extend distally whereas type C fractures are distal to the stem in the femoral shaft. The Vancouver system remains the most commonly used due to its simplicity and its application to surgical management.

Modified Vancouver Classification of Post-operative PFFs

A Proximal metaphysis

AG Around the greater trochanter

AL Around the lesser trochanter

B Bed of implant

B1 Stable stem

B2 Loose stem, good bone stock

Burst Highly comminuted fracture, more frequent in cemented stem

Clamshell* Displaced fracture of the medial cortex including residual neck, calcar and the lesser trochanter, more frequent in uncemented stem

Reverse clamshell Displaced fracture of lateral cortex with a “reverse obliquity” pattern

Spiral More frequent in cemented stem, loose bone-cement and/or cement-stem interface

B3 Loose stem, poor bone stock

C Clear of the implant, well below the prosthesis

D Clear of the implant, dividing 2 implants, a hip and a knee arthroplasty

There always remains some controversies surrounding the optimal management of peri-prosthetic fractures such as which internal fixation method is optimal in Vancouver B1 fracture and identification of stable or unstable stems when considering retention of the prosthesis (7).

Fixation option in the context of a vancouver B1 or C fracture are limited by restricted bony fixation proximally given the presence of a femoral stem and often in compromised bone stock. The use of single plate fixation for treatment of vancouver B and C type fracture with an overall failure of 33.9 %, high failure rates and need for reoperation have previously been described by Lindahl et al. The only plate is not a good choice for fixation because of high failure rate.

Cerclage wire or cable fixation is commonly employed in the management of intra-operative periprosthetic fracture at time of primary surgery however this technique may also be applied to management of post operative fracture. Cable-only fixation showed high failure rate and need revision surgery so only cable is not a good choice for fixation. A recent study demonstrated better outcome using the hybrid technique of cables and plate fixation around the stem.

Material and method

We have operated 11 cases of PPF in our hospital in last 3 years. Two fractures were Type A, seven cases were Type B and one case was Type C fractures. Type A fractures were managed by cables and stainless-steel wires. Type B fractures were managed by long plates, and Type C fracture was managed by distal femoral locking plate. Results were assessed by modified harris hip score. It was found excellent in 3 cases, good in 7 cases and fair in one patient.

Figure 1: A- Preop xray of B1 fracture, B- Post operative xray of B2 fracture

Figure 2: A- Preoperative x-ray of B2 fracture, B- Post operative x-ray

Figure 3: A- Preoperative x-ray of B1 fracture, B- Post operative X-ray

Cortical strut allograft is rarely used in isolation as they are more often applied and used in combination with plate fixation. It has been proved to be a very stable fixation. Various previous studies show that strut-graft had no added benefit over combined cable and plate fixation. It just adds as an additional procedure and economic burden to the patient.

The presence of a loose stem associated with a periprosthetic fracture requires revision arthroplasty and fixation with the aim of achieving both a stable implant and a healed fracture. Revision arthroplasty for peri-prosthetic fracture has been described using both uncemented and cemented implants. when uncemented prostheses are used, fluted titanium stem can be used to achieve diaphyseal fixation while enabling the surgeon to bypass the fracture site and achieve fixation distal to the fracture. Complications are non-union 5%, metal work failure 4%, infection 5% and reoperation in 9% cases.

Discussion

The goals of surgical treatment are restoration of anatomical alignment and length with a stable prosthesis, maintenance or enhancement of bone stock, early mobilisation and early union. Intramedullary (revision stems or nails in Type C PFFs) or extramedullary (plates, cerclages, structural graft) techniques, or a combination of both, are used to achieve these goals (1). The correct management of the fracture is demonstrated by the stability of the femoral implant: if the stem remains well-fixed the fracture can be treated with osteosynthesis, otherwise revision of the implant must be considered. Recent systematic review of internal fixation method for Vancouver Type B fractures, ORIF with cables and compression plate or locking plates have given union rate of 95%. Structural graft can add both mechanical and biological support. In the presence of loose stem revision arthroplasty with long stem prosthesis is indicated. Some author suggested that presence of fracture around a cemented stem is an absolute indication for revision arthroplasty.

Alongside recent developments in periprosthetic technology and surgical technique, demographic ageing has greatly increased the incidence of certain patient-specific complications. As we see more patients living into their sixties and beyond, we must contend with greater incidences of age-linked comorbidities, particularly osteoporosis and cognitive decline.

So, while the former of these makes fractures both more likely and more difficult to stabilize, the latter impairs patient's abilities either to avoid fractures or to comply with complex post-surgical therapeutic regimens. Consideration of such issues is essential to decide on the most appropriate approach for each patient. (4)

Essentially all periprosthetic fractures require some treatment. Stable nondisplaced fractures may only require protected weightbearing or cast/brace immobilization (and pain medication), but most unstable peri-implant fractures require surgical stabilization, implant replacement, or both to restore function. Surgical intervention follows the same guidelines for peri-implant fractures as for other fractures.

The goals of treatment include the following: Early ambulation, which helps avoid pulmonary complications, pressure injuries, disuse osteoporosis, and other complications of prolonged bedrest, restoration of axial alignment, which helps prevent eccentric stress on the prosthesis that leads to early loosening and stabilization of the limb, which allows joint motion and helps prevent stiffness and muscle atrophy. (5)

The aging population and the increasing number of patients with primary total hip arthroplasties (THA) has equated to an increased incidence of periprosthetic fractures (PPF) of the hip. These injuries are a significant source of patient morbidity and mortality, placing a financial burden on healthcare systems worldwide. As the volume of PPF is expected to along with the growing volume of primary and revision THA, it is important to understand the outcomes and factors associated with treatment success. (6)

Non-operative treatment of PPFs has been associated with poor outcomes (Nonunions and malunions), medical complications (10) except probably in cases of a critically ill patient unable to undergo any major surgical intervention. With the evolution of implants and further experience in revision surgery, operative intervention is nowadays the choice of treatment. More recently, new evidence related to anabolic drug therapies in combination with non-operative protocols, even for PPFs with an unstable prosthesis, has introduced an interesting alternative method for very frail patients, or those with minimally displaced fractures. (11)

The evolution of orthopaedic implants has provided us with more intraoperative surgical options and solutions to deal with these complex injuries, and that applies to both revision implants and fixation devices. The need though remains for even more specially designed implants to address if not all at least the vast majority of PPFs. New concepts of fracture fixation are here, such as plates with far cortical locking (FCL) and active plating. (12,13)

When managing Vancouver B3 fractures with deficient bone stock, surgeons are challenged with achieving both implant and fracture stability. It is important to recognize that bone loss encountered during the time of surgery is likely greater than initially thought on pre-operative radiographs (14). In the case of PPF with inadequate bone stock, treatment should be with a long-stemmed femoral component with bone augmentation with extra and intramedullary fixation in the form of impaction grafting or biological strut grafts (15). Another option includes a proximal femoral replacement in cases where the proximal femur cannot be reconstructed (16).

Conclusion

In the of a well-fixed stem there are various option for retaining the implant and reduction and fixation of the fracture. But loose implants require revision arthroplasty and internal fixation. Future large-scale randomised trials are needed to determine the optimum fixation with an aim to reduce these complications.

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Comparison of open v/s microscopic tubular discectomy at single level lumbar or lumbosacral spine in prolapsed inter vertebral disc patients

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Introduction: Clinical outcomes of using microscopic tubular discectomy for lumbar or lumbosacral disc herniation were evaluated by comparison with open discectomy.

Materials and Methods: As per study criteria 32 patients with low back pain with unilateral radicular pain was included in this study. After admission of patients a detailed, careful history was taken. Patient was assessed clinically to evaluate general condition; vitals were recorded and spine examination was done and radiological assessment was also done.

Result: This study includes total 32 patients undergone microscopic discectomy (16pt) and open discectomy (16 pt). In this study results showed that using tubular microdiscectomyfor lumbar or lumbosacral disc herniation was more effective than open discectomy in improving visual analogue scale score (VAS) ($p<0.05$) and Oswestry Disability Index (ODI) ($p<0.05$).

Conclusion: Based on our study it was found that tubular microdiscectomy group has better outcomes than open discectomy group in terms of visual analogue scale score (VAS) and Oswestry Disability Index (ODI). current research suggests that tubular microdiscectomy can achieve clinical results similar to those of open discectomy.

Keywords: PIVD, Microdiscectomy, Tubular microdiscectomy, Open discectomy

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Introduction

Low-back pain is the leading cause of disability worldwide. It is the second most common symptom-related reason for seeking care from a primary care physician.[1] While low back pain rarely indicates a serious disorder, it is a major cause of pain, disability, and social cost. The lifetime prevalence is over 60%. The costs associated with low back pain include the direct cost of medical care and the indirect costs of time lost from work, disability payments, and diminished productivity.[2] The extent of chronic low back pain among Indian population is alarmingly high, with approximately 79% of women between 20 to 50 years suffering from chronic pain. Lower back pain alone affects around 80% of women compared to 59% of men.[3]

Intervertebral disc (IVD) degeneration is a major contributing factor for discogenic low back pain (LBP), causing a significant global disability.[4] It is a common joint disease of all orthopedic diseases. It is mainly caused by degenerative changes of the lumbar intervertebral disc; external forces; or nerves, horsetails and other nerves.[5] The PIVD consists of an inner core proteoglycan-rich nucleus pulposus (NP) and outer lamellae collagen-rich annulus fibrosus (AF) and is confined by a cartilage end plate (CEP), providing structural support and shock absorption against mechanical loads. Thus, changes to degenerative cascades in the PIVD cause dysfunction and instability in the lumbar spine.[6]

Patients exhibit back pain, lower limb radiation neuralgia and neurological dysfunction.[5] The relationship between lumbar disc prolapse and radicular pain was first described by Mixter and Barr. Mixter and Barr in 1932, described lumbar discectomy by which an L2 to S1 exploratory laminectomy led to removal of a "mass one centimeter in diameter" that was "pressing on the left fifth nerve root and displacing the cauda equina to the right". In 1934, they first published the surgical treatment of lumbar disc herniation (LDH). [6] However, first discectomy was done by Oppenheim and Fedre Krause in 1906 though the first publication was done by Mixter and Bar.[7]

Surgical treatment is well known to be beneficial for patients with LDH who fail to respond to conservative care.[8] Surgery is offered to patients with persistent leg pain that is refractory to conservative treatment. The open surgical technique has been described since the early 20th century. Since its introduction, alternative methods for operating disc pathologies have been developed.[9] With the continuous progress of microsurgery, the surgical techniques of LDH treatment have been developed rapidly. Later in 1977, Caspar and Yasargil first applied the conventional microdiscectomy (CMD) to the surgical treatment of LDH. [10, 11]

Newer techniques were developed with the objective of achieving less tissue trauma in a fast and efficient way. [9] The minimally invasive technique of transmuscular tubular discectomy (TD) was introduced in 1997 by Foley and Smith which is a procedure that combines spinal endoscopy and the techniques used in microdiscectomy.[12] Hence, with the introduction of the microscope, the original laminectomy was refined into microdiscectomy (MD).[9]

Material and method

The study was conducted at the Department of Orthopaedics at R.D. Gardi Medical College, Ujjain. This study was completed within two years after receiving approval from the ethics committee. This is a prospective observational study.

Written informed consent was obtained from all patients before enrolling them for the study. The patients admitted in the department of orthopaedics coming with a complain of lower back pain with radicular symptoms. were enrolled for this study as per the following exclusion and inclusion criteria.

Inclusion criteria was patients with unilateral back pain with radicular symptoms (pain, paresthesia weakness), lumbar or lumbosacral single level prolapsed intervertebral disc patients, patient not responding to conservative treatment for 6weeks and patients above 20years of age and of both genders.

Exclusion criteria was age less than 20 years, revision surgery, infection and bleeding disorders, more than one level involvement or bilateral symptoms, patients who are not fit for surgery, patient with dynamic instability and patients with congenital narrow canal, multilevel disc herniations, cauda equina syndrome, spondylolisthesis, central canal stenosis, pregnancy, and severe somatic or psychiatric diseases As per study criteria 32 patients with lower back pain with radicular symtoms was included in this study.

After admission of patients a detailed, careful history was taken. Patient was assessed clinically to evaluate general condition; vitals were recorded and detailed spine examination was done.

Radiological assessment was done to identify the level of herniation and preoperative routine investigation was done. By chit system 16 patients were placed in group A underwent microscopic tubular discectomy and remain 16 into group B underwent open discectomy.

Clinical outcomes were evaluated by Oswestry disability index (ODI) scores and visual analog scale (VAS) scores for leg and back pain. Back and leg VAS and ODI scores were assessed before surgery (preoperative), at the 6 weeks from surgery (postoperative), and subsequently at 1year.

Figure 1: A and B, pre op and post op SLRT

Figure 2: Intra op image of open discectomy from L4, L5

Figure: 3 A and B pre op and post op SLRT

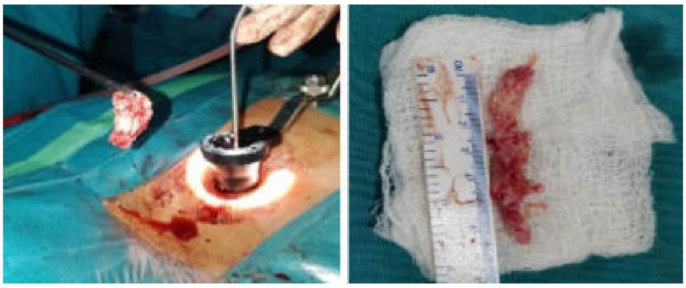

Figure 4: A and B Microscopic tubular, discectomy, intraop image & disc material removed from L4L5

Results

Table 1: Comparison of mean ODI score of study subjects in two groups at different time intervals

Time -Intervals	Group	Mean	Std. Deviation	t value	p value
Pre-Op	Group A (microscopic discectomy)	39.00	12.52	2.451	.024*
	Group B (Open discectomy)	30.88	4.36		
6Weeks (post-op)	Group A (microscopic discectomy)	15.19	5.80	5.581	<0.001*
	Group B (Open discectomy)	15.94	3.21		
1yr (post-op)	Group A (microscopic discectomy)	3.43	0.77	5.226	< 0.0001
	Group B (Open discectomy)	10.37	5.25		

Table 1 shows comparison of mean ODI score of study subjects in two groups at different time intervals results revealed that preop mean ODI score was found 39.00 in group A and 30.88 in group B it was found **statistically significant** (P=0.024), At 6 weeks mean ODI score was found 15.19 in group A and 15.94 in group B it was found **statistically significant** (P<0.001) and after 1 year mean ODI score was found in 3.43 in group A and 10.37 in group B it was found **statistically significant** (P<0.0001) (Graph 4).

Table 2: Comparison of mean VAS score of study subjects in two groups at different time intervals

Time -Intervals	Group	Mean	Std. Deviation	t value	p value
Pre-Op	Group A (microscopic discectomy)	8.56	4.25	0000	1.000
	Group B (Open discectomy)	8.56	0.62		
6Weeks (post-op)	Group A (microscopic discectomy)	4.87	2.52	2.24	0.03*
	Group B (Open discectomy)	6.31	0.60		
1yr (post-op)	Group A (microscopic discectomy)	0.75	10.62	4.92	<0.001*
	Group B (Open discectomy)	2.37	1.14		

Table 2 shows comparison of mean VAS score of study subjects in two groups at different time intervals results revealed that preop mean VAS score was found 8.56 in group A and 8.56 in group B it was found **statistically non significant** (P=1.000), At 6 weeks mean VAS score was found 4.87 in group A and 6.31 in group B it was found **statistically significant** (P=0.03) and after 1 year mean VAS score was found in 0.75 in group A and 2.37 in group B it was found **statistically significant** (P<0.001) (Graph 2).

Discussion

Clinical outcomes were evaluated by Oswestry disability index (ODI) scores and visual analog scale (VAS) scores for leg and back pain. Back and leg VAS and ODI scores were assessed before surgery (preoperative), at the 6 weeks from surgery (postoperative), and subsequently at 1year.

For Oswestry disability index (ODI), the patient checks the statement of the index and decides which most closely resembles their situation. Each question is scored on a scale of 0–5 with the first statement being zero and indicating the least amount of disability and the last statement is scored 5 indicating most severe disability.

The scores for all questions answered are summed, then multiplied by two to obtain the index (range 0 to 100). Zero is equated with no disability and 100 is the maximum disability possible.[10] The comparison of the average ODI scores of the study subjects in two groups at different time intervals was statistically significant with lower values in the open discectomy group.

The preoperative average ODI score was 39.00±12.52 in group A (microscopic tubular discectomy) and 30.88±4.36 in group B (open discectomy) (p=0.024); at 6 weeks, the average ODI score was 15.19±5.80 in group A (microscopic tubular discectomy) and 5.94±3.21 in group B (open discectomy) (P<0.001).

After 1 year, the average ODI score was 3.43±0.77 in group A (microscopic tubular discectomy) and 10.37±5.25 in group B (open discectomy) (p<0.0001). **Zhang et al[11]** pooled analysis included four randomized controlled studies with a total of 523 patients they reported ODI score of tubular microscopic disectomy was more better than conventional discectomy patients.

Gupta P12 they operated 130 patients with open discectomy and 120 patients with microscopic tubular discectomy there was great reduction in ODI score in microscopic tubular discectomy patients as compare to pateints underwent open discectomy at 4weeks but at 1 month both are comparable. **Yasseen MA13** divided patient in two groups total of 40 patient with single level lumbar disc herniation. 20 patients underwent open discectomy and 20 patients underwent microscopic tubular discectomy.

The study reported statistically significant decrease in mean total ODI score was recorded in microscopic discectomy as compare to open discectomy. **Hamawandi SA et al14** out of 60 patients (group A = open discectomy & group B = microdiscectomy) the ODI preoperatively and postoperatively through all periods of assessment in both groups A and B, there is significant deference which means that both methods of treatment are effective in achieving excellent functional improvement for patients with symptomatic lumbar disc herniation.

The difference of the VAS score between the open discectomy group and microscopic tubular discectomy treatment group was found to be statistically significant post- operatively with lower values in the open discectomy group. The mean VAS score was found 8.56 in group A (microscopic tubular discectomy) and 8.56 in group B (open discectomy) pre-op (p=1.000), post-op at 6 weeks was 4.87 in group A (microscopic tubular discectomy) and 6.31 in group B (open discectomy) (p=0.03) and after 1 year was in 0.75 in group A (microscopic tubular discectomy) and 2.37 in group B (open discectomy) (p<0.001).

Gupta P12 they operated 130 patients with open discectomy and 120 patients with microscopic tubular discectomy there was greater reduction in VAS score in microdiscectomy as compare to open discectomy but at 1 month both are comparable. **Hamawandi SA et al14** out of 60 patients (group A = open discectomy & group B = microdiscectomy) they reported that there was significant difference in post-operative VAS score between open discectomy and microscopic discectomy patients. **Li, Xianbo MDa et al15** the pooled analysis where 8 randomized controlled trials and 2 retrospective studies were included and 804 patients were evaluated. they reported no significant difference between conventional discectomy and tubular microscopic discectomy. **Overdevest GM et al16** double-blind randomised controlled trial done where 325 patients with a symptomatic lumbar disc herniation were randomly allocated to tubular discectomy (166 patients) & conventional microdiscectomy (159 patients). Mean differences for VAS leg pain and back pain were 0.2 (95% CI -5.5 to 6.0) and 0.4 (95% CI -5.9 to 6.7), respectively. 77% of patients allocated to conventional discectomy reported complete or near-complete recovery of symptoms compared with 74% of patients allocated to tubular discectomy (p=0.79). **Hermantin FU et al17** out of 30 patients they reported that patients managed with open laminotomy and discectomy used narcotics for a longer duration postoperatively than patients managed with microdiscectomy.

Conclusion

To conclude, our study found visual analog scale (VAS) for pain & Oswestry Disability Index (ODI) scores were better in microscopic tubular discectomy than open discectomy. Thus, both the methods are safe and effective and surgeon needs to decide taking into consideration patient associated factors.

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Functional and clinical outcome of fracture clavicle treated by nailing vs plating technique: a comparative study

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Introduction: Clavicle bone fractures are among of the most common bony injuries encountered in orthopaedic opd and emergencies. Clavicle fractures are commonly seen in young adult. The most common site of fracture in the clavicle occurs at the middle third and which accounts for almost 80% of all clavicle fractures. This study is done to compare the functional and clinical outcome of fracture clavicle treated with nailing vs plating.

Material and method: This study includes 44 patients with diagnosed clavicle fractures. After admission thoroughly history was taken and clinical examination done with general condition, vitals and radiological assessment was also done. After getting PAC fitness patients taken randomly by chit system for surgical fixation of fracture either by nailing or plating technique.

Results: Our study shows that nailing technique is better than plating technique on the basis of CMS score.

Conclusion: Based on the data of 44 patients, the TENS method appears to be a favourable option than plating for orthopaedic treatment due to its less invasive nature, faster recovery times, and better early functional outcomes. However, the final decision should also consider the specific fracture pattern,clinical scenario, patient preferences and the potential for long-term complications.

Keywords: Clavicle fracture, Nailing, Plating, CMS score

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Introduction

Clavicle bone fractures are among of the most common bony injuries encountered in orthopaedics. They are most common in children and half of fracture are below age of 7 years and comprise around 2.4% to 2.6% of all fractures attended in orthopaedic department [1]. Approximate 50% of clavicle are displaced fracture. This fracture also has the high rate of shoulder dysfunctions and, which affect the daily routine of patients.

Clavicle fractures are commonly seen in young adult. The most common site of fracture in the clavicle occurs at the middle third and which accounts for almost 80% of all clavicle fractures [2,3]. As it is the thinnest part of the bone devoid of any muscular or ligamentous attachment [4,5]. Incidence varies between 29 and 64 per 100000 population [1]. In young adults they usually occur as a result of high velocity trauma and sometime have associated injuries.

Research has shown that surgical procedures led to better functional outcomes and higher rates of union compared to conservative approaches [5]. Other problem with non-operative method is immobilization of shoulder for at least 6-8 weeks and the further time required to regain the functions of shoulder joint by physiotherapy. During this entire time of management, patient's ability to carry out day to day movements and activities is affected. It can also be complicated with venous congestion of arms & neuropraxia (as the displaced fragment compresses the brachial plexus) and malalignment of fracture may lead to shortening of clavicle >1-2 cm [6]. Numerous other methods of treating injuries of displaced fracture clavicle like closed intramedullary nailing, open intramedullary nailing, clavicle plating have enjoyed recognition from time to time due to early mobilization and less time needed for physiotherapy which testifying the fact that there is no ideal modality of treatment.

The functional outcome of treatment of fracture clavicle is influenced by the anatomical reduction. By directly restoring the anatomy, plating allows secure internal fixation with resultant early return of clavicle function. Intramedullary nail fixation is a less invasive procedure with less blood loss and shorter duration of stay in the hospital, smaller post operative scar and better cosmetic results as well as the chances of preserving the blood supply to the clavicle. It has disadvantages like malrotation, overriding of fragments, irritation at the entry site, implant migration and needs implant removal [7].

Plate osteosyntheses fixation is a more stable procedure with less chances of malrotation and overriding, but has disadvantages like bigger scar, prominence of plate leading to skin necrosis and infection [6]. But protection of reduction and chances of loss of reduction is little more concern in nailing compared to plating. We have done study on 44 patients, 22 in Intramedullary Nailing group (Group A) and 22 in Plating group (Group B) with the aim to evaluate the functional and clinical results of clavicle plates vs nailing for treating fractures of the clavicle.

Materials and methods

This study was conducted in the department of orthopaedics of R.D Gardi Medical College and associated C.R.G.H, Ujjain during the year April 2022 to December 2023. In this study, 44 cases of Fracture Clavicle were admitted and divided into two procedure groups, Intramedullary Nailing and Plating and operated via either of the procedure and the outcome after the surgery was assessed by the Constant Murley Shoulder (CMS) Score.

For collection of data ethical clearance was taken from Human Research Ethical Committee of R.D Gardi Medical College, Ujjain. Inclusion criteria was adult patients with displaced clavicle fractures who require surgical intervention, age >18years and < 65 years both male and female and patients who have given consent for surgery

Exclusion criteria was patients with pathological fractures, open fractures Gustilo and Anderson type II or type III fracture with vascular injury, patients with neurovascular injuries**,** patients >18 years and <65 years**,** patients not willing for surgery and patients with moderate to severe comorbidities Patient showing positive clinical findings for fractures and on imaging modality like X-RAY. Constant Murley Shoulder (CMS) Score pre operatively evaluate and recorded for post operative follow-up comparison.

Patient then Randomly taken through chit system for surgery either for Nailing or Plating after getting PAC fitness. 22 patients were operated with Intramedullary nailing and 22 patients were operated with Plating by superior approach.

Figure 1: Intra op pics of Intramedullary nailing

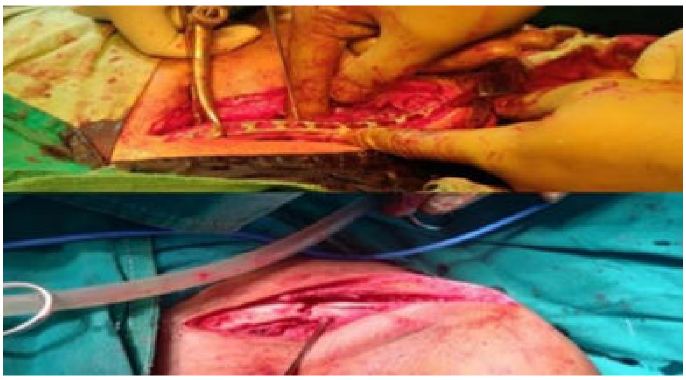

Figure 2: Intraoperative pic of plating

Patients were regularly followed after 1, 3and 6 months. At 1 ,3 and 6 months CMS was calculated and noted. X ray Clavicle (ap, lateral and oblique views) taken. Functional outcome was assessed according to Constant Murley Shoulder (CMS) Score post operatively. Post operative management is done by patient were given universal shoulder immobilizer. **S**ymptomatic treatment was given. Active elbow movement started from pod 2 and shoulder pendulum exercises started as early as possible when patient was able to tolerate pain. Suture removal done on pod 12.

Figure 3,4, 5 and 6: Case 1 (TENS) A 36 Y old male with follow up

Figure 7, 8, 9, 10 11 and 12: Case 2 Clavicle plating with follow up

Three patients of TENS have protrusion of nail from medial side after 3-4 months. Since patient present after 3 months so fracture have united radiological and clinical and nail removal done. There was no complication after removal of nail like infection or fracture.

Results

In our study mean age was found 36.91±10.39 years, median age 36 years. Minimum age 20 years and maximum age 60 years. The distribution of cases across different age groups reveals that the majority are in the 31-40 years age groups, comprising 16(36.4%) of the total.

Those aged 30 years or younger account for 29.5%, while the 41-50 years group represents 25.0%. Participants over 50 years make up the smallest segment at 9.1% TENS group has a mean skin incision length of 1.2 cm with a standard deviation of 0.37 cm, while CPS group has a mean skin incision length of 9.68 cm with a standard deviation of 0.72 cm.

The calculated t-value is 49.405, and the corresponding p-value is 0.000. This indicates a highly significant difference in the mean skin incision length between both study groups.

Table 1: Duration of surgery (in min) comparison between two study groups

	TENS		CPS		T	P
	Mean	SD	Mean	SD		
DURATION OF SURGERY (in min)	49.77	7.32	69.32	9.04	7.885	0.000

TENS group has a mean duration of surgery of 49.77 minutes with a standard deviation of 7.32 minutes, while CPS group has a mean duration of surgery of 69.32 minutes with a standard deviation of 9.04 minutes. This indicates a highly significant difference in the mean duration of surgery between TENS and CPS group.

TENS has a mean blood loss of 7.95 ml with a standard deviation of 2.95 ml, while CPS has a mean blood loss of 94.55 ml with a standard deviation of 26.14 ml. This indicates a highly significant ($p<0.01$) difference in the mean blood loss between both groups.

Table 2: Mean CONSTANT-MURLEY SHOULDER (CMS) score pre and post operative comparison between two study groups

CMS SCORE		TENS		CPS		T	P
		Mean	SD	Mean	SD		
Pre operative		31.23	3.49	29.59	3.33	1.590	0.119
Post-operative	1M	65.64	3.24	61.77	2.99	4.107	0.000
	3M	80.68	1.91	78.91	1.72	3.237	0.002
	6M	94.14	2.34	93.64	1.68	0.815	0.419

The pre-operative Constant-Murley Shoulder (CMS) scores for TENS and CPS were 31.23 (SD = 3.49) and 29.59 (SD = 3.33), respectively, showing no statistically significant difference between the two groups (p = 0.119).

However, significant differences emerged post-operatively. At 1 month, Group A had a mean CMS score of 65.64 (SD = 3.24), while CPS had a mean of 61.77 (SD = 2.99), with TENS group showing significantly higher scores (p = 0.000). This trend continued at 3 months, where TENS had a mean CMS score of 80.68 (SD = 1.91) compared to CPS group 78.91 (SD = 1.72), again indicating a significant difference (p = 0.002). By 6 months post-operatively, the CMS scores for TENS group (94.14, SD = 2.34) and CPS group (93.64, SD = 1.68) were similar, with no statistically significant difference observed (p = 0.419).

The mean radiological union time for fractures in TENS was 11 weeks (SD = 1.63), while in CPS, it was 12.86 weeks (SD = 1.36). The independent samples t-test revealed a statistically significant difference between the two groups (t = 4.119, p = 0.000), indicating that fractures in TENS group tended to achieve radiological union faster compared to CPS group. This finding suggests that the intervention or treatment protocol associated with TENS group may have contributed to accelerated bone healing compared to CPS group. The results highlight the potential effectiveness of the approach used in TENS group for promoting faster fracture healing based on radiological assessments.

The mean duration of hospital stay for patients in TENS group was 2.64 days (SD = 0.85), whereas for those in CPS group, it was 5.05 days (SD = 0.72). The difference between the two groups was statistically significant (t = 10.146, p = 0.000), indicating that patients in TENS group had a significantly shorter hospital stay compared to CPS group. This suggests that the management or treatment approach used in TENS group may have led to quicker recovery or more efficient care delivery, resulting in reduced hospitalization periods. These findings underscore the potential benefits of the protocols implemented in TENS group for optimizing hospital resource utilization and improving patient outcomes related to the duration of hospital stay.

Majority of cases, 40(90.9%), did not had complications. However, 3(6.8%) of the cases had medial migration, and 1(2.3%) case had to implant loosening.

Table 3: Association between complications and our study groups

COMPLICATION	Group		Total
	TENS	CPS	
PLATE LOOSNING (RE PLATING)	0	1	1
	0.0%	4.5%	2.3%
MEDIAL MIGRATION OF NAIL	3	0	3
	13.6%	0.0%	6.8%
NIL	19	21	40
	86.4%	95.5%	90.9%
Total	22	22	44
	100.0%	100.0%	100.0%
Chi-square=5.231, p=0.264			

The table indicates that, there is no statistically significant association between complications and study groups with p=0.264. In TENS group, there was 1 case of Implant Loosening (4.5%), 3 cases of Medial Migration (13.6%), and 19 cases with no complications (86.4%).

In CPS group had 1 case of Implant Loosening (2.3%), no cases of Medial Migration (0.0%), and 21 cases with no complications (95.5%).

Discussion

The present study involved 44 cases with a predominant number of male participants (86.4%). The age distribution showed that most participants were between 31-40 years (36.4%), followed by those aged ≤30 years (29.5%), 41-50 years (25.0%), and >50 years (9.1%). There was no statistically significant difference in the mean age between the TENS group (35.77 years) and the CPS group (38.05 years). Minimum age were 18 years and maximum age were 60 years. In present study out of 44 cases majority of 38(86.4%) cases were males and 6(13.6%) cases were females.

In study by **Vajrangi a et al** total of 38 patients were included and mean Age in years was 42.74 in plating and 31.32 in nailing and the difference of the age between the groups was found to be significant (p=0.008). Male and female ratio was 15:4 in plating and 16:3 in nailing [3].

Studies by **Nowak et al** on 185 patients found a higher incidence of clavicle fractures among males (70 per 100,000) compared to females (30 per 100,000) [8].

Postacchini et al reported that 68% of isolated clavicle fractures occur in men, with the left clavicle being affected in 61% of cases [9].

In other study by **Siddharth Yadav et al** in prospective comparative study, the functional outcome and union time for TENs and plate fixation has been compared across 62 patients presenting with clavicle fracture. Among them, 40 patients (65%) were male, and the remaining were female. While most patients (48.39%) were between 21 and 30 years, the age range varied from 17 to 60 years [10].

In study by **Pan Hong et al** a total of 73 patients were included. Patients were categorized into two groups ($n = 45$; 27 males, 18 females) and plate ($n = 28$; 17 males, 11 females), according to surgical technique. The average age of patients in group was 12.2 ± 1.5years, and that in plate group was 12.2 ± 1.4years [88]. A total of 45 patients, including 27 males and 18 females, were included in elastic stable intramedullary nailing (ESIN) group, and 28 patients, including 17 males and 11 females, were included in plate group. There was no significant difference between ESIN group and plate group in terms of sex, age, operated side, body weight, and time from injury to surgery [11]. In present study the most common cause of injury was road traffic accidents (RTA), accounting for 61.4% of cases. Falls were second most frequent cause (27.3%), followed by assaults (11.3%).

In study by **Vajrangi et al** most common mechanism of injury was fall on an outstretched hand which accounted for nearly 52.6% of cases in plating group and 63.2% of cases in intramedullary nailing group [3].

Postacchini et al identified motor vehicle accidents as a significant cause of such direct trauma leading to clavicle fractures [12].

Zhu et al.'s study on an urban Chinese population found that road traffic accidents were predominant cause of clavicle fractures in that demographic [13].

Siddharth et al study shows that in total of 62 patients, 42 (67.74%) patients had clavicle fractures from road accidents, 15 (24.19%) from falls, and five(8.06%) from assaults [10].

Saeed Asadollahi et al studied on 134 patients and concluded that most common mechanism of injury was a road traffic accident (78%). Sixty percent (n=83) had an injury severity score of ≥15 indicating major trauma [14].

In a study by **Gadegone and Lokhande et al** (36 patients), causes of injuries were distributed as follows: 21 cases (58.3%) were due to road traffic accidents (RTA), 12 cases (33.3%) were due to falls, and 3 cases (8.3%) resulted from sports injuries [15].

By **Bostmann et al**, injury mechanisms included falls from two-wheelers in 38 patients (36.8%), slipping and falling in 24 patients (23.3%), RTAs in 19 patients (18.45%), and sports injuries in 22 patients (21.36%) [16].

Hartmann et al. reported that 46% of cases were caused by RTAs, 34% by sports injuries, and 20% by falls [17]. In present study TENS group required significantly smaller skin incisions (mean 1.2 cm) compared to CPS group (mean 9.68 cm). This indicates that TENS method is less invasive.

In study by **Siddharth et al** plating procedure requires large incisions and can injure soft tissues to cause several postoperative complications. Thus, intramedullary fixation (TENs) stands out as a minimally invasive alternative to plate fixation [10].

Meta analysis done by **Gao y et al** included six randomized controlled trials (RCTs) and nine non-randomized controlled trials (non-RCTs). The study included 513 patients in intramedullary fixation group and 521 patients in plating group. This analysis shows advantage of nailing in small incision site [18].

Pan Hong et al study concluded that ESIN group demonstrated a significantly shorter incision length (2.4 vs. 5.4cm) than plate group ($P < 0.001$). The SCAR scale was higher in plate than in ESIN group at all time points ($P < 0.001$), and rate at which cosmetic counsel was sought due to esthetic concerns was also much higher in plate group (71.4%) than in ESIN group (22.2%) ($P < 0.001$) [11]. In present study duration of surgery was significantly shorter in TENS group (mean 49.77 minutes) compared to CPS group (mean 69.32 minutes). This suggests that TENS procedure is quicker. Blood loss during surgery was significantly less in TENS group (mean 7.95 ml) compared to CPS group (mean 94.55 ml). This highlights less invasive nature of TENS procedure.

Siddharth y et al study concluded that plate fixation had greater intraoperative and postoperative problems than TENs, including more blood loss and more operative time [10].

Meta analysis done by **Gao y et al** shows less blood loss and less operative time in nailing compare to plating [18].

Pan hong et al, ESIN group demonstrated a significantly shorter operative time (31.1 vs. 59.8min) [11].

Weina Ju et al, Meta-analysis of 1420 records show increased surgical time and soft-tissue stripping with plate fixation [19].

K F Braun et al, Open reduction increases operative time significantly versus closed reduction (open 80.8 ± 35.9 min; closed 30.5 ± 8.5 min) [20].

In present study duration of hospital stay was significantly shorter for TENS group (mean 2.64 days) compared to CPS group (mean 5.05 days). This indicates a quicker recovery for patients treated with TENS method. By **vajrangi et al** The hospital stay for nailing group (mean 7.95 days) was shorter than that for plating group (mean 9.74 days). This difference was statistically significant (p=0.048) [3].

Pan hong et al ESIN group demonstrated a significantly shorter hospital stay (1.5 vs. 2.5days) [11].

In present study Pre-operative CMS scores were similar between two groups. However, post-operative scores were better in TENS group at 1 month and 3 months. By 6 months, scores were similar between two groups.

Study done **by Amit Rahangdale** et al research showed that study found that both titanium elastic nails (TENs) and plate fixation have their advantages and disadvantages for treating displaced mid-shaft clavicle fractures. However, choice of surgical method does not significantly impact final functional outcomes measured by DASH and Constant Murley scores [5].

By **Siddharth y et al**, distribution of scores was very similar between two groups, where 29 (93.55%) patients had an excellent functional outcome. While remaining two patients from CPS group had a good functional outcome, for TENS group, one had a poor, and other had a good functional outcome. During follow-up period of 12 month, Constant-Murley scores were not statistically different between two groups. Still, average score for CPS group (95.45+4.28) was slightly higher than for TENS group (94.19+8.88). deviation of Constant-Murley scores from its average for TENS group (SD=8.88) was twice that of CPS group (SD=4.28) [10].

Jun Sung Park et al done research on 97 patients and conclude that clavicle plate and intramedullary nail (TEN) fixation methods showed very good outcomes in terms of bone union rates and functional scores across all types of clavicle fractures. Patient satisfaction was notably higher with intramedullary nail (TEN) fixation compared to plate fixation [21].

Meta analysis done by **Gao y et al** shows there were no statistically significant differences found between two groups in terms of shoulder function [18].

Weina Ju et al in their meta-analysis of 1420 records found sufficient data on Constant-Murley scores for meta-analysis were available from 7 studies. Analysis of pooled data of 215 patients undergoing plate fixation and 216 patients undergoing intramedullary fixation revealed no statistically significant difference in Constant-Murley scores between two groups [19].

K F Braun et al, no significant differences were found regarding Constant score (87.4 ± 9 points closed group vs. 85.3 ± 7.2 points open group) [20].

Marijn Houwert et al systemic review on 4 studies found no significant difference between plate fixation and intramedullary fixation after 12months in functional outcome (Constant score*p* = 0.37) [90]. He also found that Bohme et al. reported in an observational cohort study a Constant score of 97 for the intramedullary fixation group and of 94 for the plate fixation group after eightmonths[22].

XinDuanMD et al did a randomized clinical trial on Four studies which involved 305 clavicular fractures. There were no significant differences between plating and intramedullary pinning with regard to outcome for Constant Shoulder Score [23]. In present study the mean radiological union time was significantly faster in the TENS group (11 weeks) compared to the CPS group (12.86 weeks). This suggests that the TENS method promotes faster bone healing.**Vajrangi et al,** The difference in time taken for union in weeks between the plating group (12.89 with SD of 3.23) and nailing group (12.67 with SD of 1.53) was statistically not significant (p=0.675) [3].

Siddharth et al, comparing the healing time, the early formation of callus facilitated swift healing in TENS group [10].

Meta analysis done by **Gao y et al** shows faster union rate in nailing group. The study included 513 patients in the intramedullary fixation group and 521 patients in the plating group. [18].

Wei Zhang et al found that the mean union time was 11.5 weeks in nailing group [24].

In present study the majority of the cases (90.9%) did not experience any complications. However, there were differences in complications between the two groups. In the TENS group, 13.6% of the cases had medial migration, whereas in the CPS group, 4.5% had implant loosening.

In study by **vajrangi et al** there were Complications seen in six patients (31.5%) in each group. Three patients (15.8%) developed implant loosening in plating group. They also had restriction of movement of the shoulder as they were immobilised for longer periods. One of these cases (5.3%) led to non-union. One patient (5.3%) had prominence of plate with irritation of skin. Four patients (21.05%) required implant removal out of which three had implant loosening and one had plate prominence. In the nailing group, one patient (5.3%) had superficial infection on the medial side at point of entry of nail. Three patients (15.8%) had irritation of the skin on the medial end of clavicle from where the nail was inserted. Implant removal was performed in all the patients after six months of surgery. No difficulties were encountered during the implant removal in both the groups. Two patients (10.5%) had implant failure and non-union of which one re-fractured due to a fall and the other had migration of implant through the comminuted fragment. There was no statistically significant difference on comparing the complications in both the groups (p=0.189) [3].

Study by **Siddharth et al** observed a higher occurrence of superficial infection among group I (TENs) patients. However, none of the patients had deep infections at the operating site when treated by TENs. Still, other complications, including ugly scar, implant protuberance, pin migration, and non-union, were encountered [10].

In study by **Pan Hong et al** it was shown that two patients (7.1%) in the plate group suffered a refracture after implant removal. The rate of implant prominence was higher in the ESIN group (44.4%) than in the plate group (32.1%). The rate of surgical site infection (SSI) was low in the ESIN group (4.4%) and the plate group (7.1%) [11].

In study by **Saeed Asadollahi et al** the overall incidence of complication was 14.5% (n=20). The overall nonunion rate was 6%. Postoperative wound infection occurred in 3.6% of cases. The incidence of complication associated with plate fixation was 10% (11 of 110 cases) compared to 32% associated with intramedullary fixation (nine of 28 cases; P=0.003). Thirty-five percent of complications were related to inadequate surgical technique and were potentially avoidable. Symptomatic hardware requiring removal occurred in 23% (n=31) of patients. Symptomatic metalware was more frequent after plate fixation compared to intramedullary fixation (26% vs 7%, P=0.03) [14].

Weina Ju et al, Meta-analysis of 20 study on 1999 patients indicated a statistically significant 2.74-fold increased risk of nerve injury-related complications with plate fixation. Implant associated complications, including implant protrusion, skin irritation and pain over hardware were also reported. Results indicated that plate fixation was associated with a 2.38-fold increased risk of complications not requiring non-routine surgery, as compared to intramedullary fixation [19].

A systemic review by **R. Marijn Houwert** on 4 studies shows Complications in 12% of the intramedullary fixation group and in 40% of the plate fixation group [22].

Conclusion

Based on the data, the TENS method appears to be a favourable option than plating for orthopaedic treatment due to its less invasive nature, faster recovery times, and better early functional outcomes. However, the final decision should also consider the specific clinical scenario, patient preferences, and the potential for long-term complications.

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Comparison Of Functional Outcome of Metacarpal Fractures Treated by Anterograde Vs Retrograde Approach of Intramedullary Pinning

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Purpose: Metacarpal fractures are a common injury, constituting a significant portion of upper extremity fractures. The purpose of this study is to compare the functional and radiological outcomes of anterograde vs. retrograde intramedullary pinning in the treatment of shaft metacarpal fractures.

Material and Method: This prospective study was conducted from February 2021-September 2022, involving 60 patients aged 18-65 years with closed, displaced metacarpal fractures. 30 patients received anterograde and another 30 received retrograde intramedullary pinning. Follow-up assessments were done at 2, 4, 6, and 12 weeks. Radiological and clinical outcomes were evaluated using TAM score, grip strength measurements, VAS scores, and standard radiographic analyses.

Results: Mean age of patients in anterograde group was 34.60±7.35 years, while the retrograde group had a mean age of 32.53±8.80 years. The anterograde group demonstrated significantly higher grip strength at both 6 and 12 weeks postoperatively (p-value<0.0001) and lower VAS scores for pain at 2 and 6 weeks (p-value<0.0001). Radiological union was achieved faster in the anterograde group (mean union time=5.21 weeks) compared to the retrograde group (6.89 weeks). Stiffness was the most common complication, observed in 16.7% of the anterograde group and 23.3% of the retrograde group. The anterograde group also showed a higher percentage of patients achieving excellent results (46.4% vs. 23.4% in the retrograde group).

Conclusion: Anterograde intramedullary percutaneous pinning is a superior technique compared to retrograde pinning for the management of metacarpal fractures. It offers faster functional recovery, better grip strength, and reduced pain in the early postoperative period, with fewer complications.

Keywords: Metacarpal fractures, anterograde pinning, retrograde pinning, functional recovery, grip strength

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Introduction

Fractures of the metacarpals and phalanges are prevalent, constituting approximately 10% of all upper extremity fractures. [1] Epidemiologically, 30-40% of all hand fractures involve the metacarpals, with the border metacarpals (specifically the 1st and 5th) being most frequently affected. [2,3] The 5th metacarpal alone represents 50-55% of total metacarpal fractures, while the 1st metacarpal accounts for 7-10%. [2,3] Fractures commonly occur at the base of the metacarpal rather than at the neck, and diaphyseal fractures are more typical in the non-border metacarpals. [2,3] The lifetime incidence of metacarpal fractures is estimated at 2.5%, with these injuries being more prevalent in males, particularly between the ages of 10 and 40 years—a period often associated with increased athletic activity and industrial exposure. [2,3] Hand fractures can result in deformity due to inadequate treatment, stiffness from excessive treatment, or a combination of both from suboptimal management. [4] Historically, the closed treatment of hand fractures has garnered a poor reputation due to complications such as malunion, stiffness, shortening, and, in some cases, loss of skin or other soft tissues. However, advancements in modern techniques and materials for internal fixation have significantly improved outcomes, offering a superior alternative to older methods. [4,5] The selection of optimal treatment for metacarpal fractures depends on several factors, including the location of the fracture (intra-articular vs. extra-articular), fracture geometry (transverse, spiral, oblique, or comminuted), the presence of deformity (angular, rotational, shortening), whether the fracture is open or closed, associated soft tissue injury, and fracture stability. [6] In some cases, the fracture fragments may be small and comminuted, making reduction and stabilization challenging, which can result in malunion, incongruity, or joint space narrowing. Additional factors that complicate treatment include damage to tendons, ligaments, and the articular capsule at the time of injury. [7,8] The fundamental principles in managing these fractures include anatomical reduction, stable fixation, and early mobilization to restore hand function fully and rapidly. Operative fixation should be employed judiciously, with the expectation that the outcome will be at least as favourable, if not superior, to that of non-operative treatment. [7,8] The primary goals of treatment are to achieve full and rapid restoration of hand function and to allow early movement, thereby avoiding the risks associated with prolonged immobilization. The specific aim of this study is to compare the functional and radiological outcomes of anterograde versus retrograde intramedullary pinning in the treatment of shaft metacarpal fractures.

Material and method

This prospective study was conducted from February 2021 to September 2022, after approval from the Institutional Ethics Committee. The study included 60 consenting patients aged between 18 and 65 years with closed, displaced fractures affecting one or two metacarpals. Patients outside this age range or with more than two metacarpal fractures, ipsilateral fractures in the same limb, neurovascular deficits, or compound metacarpal fractures were excluded. Upon admission, a detailed history and examination were conducted to identify any associated injuries, including vascular injuries, compartment syndrome or peripheral nerve injuries. Standard radiographs, including anteroposterior and oblique views, were taken for diagnosis and fracture pattern assessment.

Laboratory investigations, such as complete blood counts, serum electrolytes, and RA factor, were also conducted. Temporary immobilization using Charnley's splint was provided while awaiting surgery. Thirty patients were treated using the anterograde approach of intramedullary pinning, while the remaining thirty patients underwent the retrograde approach of intramedullary pinning. The surgical procedure was carried out under regional anaesthesia (brachial or wrist block). Patients were positioned supine, and the affected limb was abducted and prepped in sterile conditions. Closed reduction was attempted under image intensifier guidance, and the procedure was performed accordingly.

Post-operatively, intravenous antibiotics were administered for three days, followed by oral antibiotics for an additional five to seven days. Patients were encouraged to engage in early finger and wrist movements to reduce oedema and promote circulation. Post-operative radiographs were taken the day after surgery to confirm reduction and pin placement. Regular follow-up visits were scheduled at two, four, six, and twelve weeks post-operatively to assess union, complications, and improvement in range of motion at the metacarpophalangeal joint. Grip strength, range of motion, and pain (measured via the VAS score) were evaluated at each follow-up visit. Clinical outcomes were measured using several parameters, including the Total Active Motion (TAM) score for the 2nd to 5th metacarpals and Gingrass criteria for the 1st metacarpal. Grip strength was assessed using a dynamometer. The final outcomes were categorized as excellent, good, fair, or poor based on these measurements.

Statistical analysis was done using SPSS 25.0 (trial version). Continuous data was expressed in mean and standard deviation. The descriptive representation of data was done in the form of frequencies and percentages. Analytical part was done using t-test. The result was considered significant at 95% level of significance and p-value<0.05.

Results

Table 1 presents the distribution of various parameters among the two groups of study participants. The mean age of patients in Group 1 was 34.60±7.35 years, while Group 2 had a slightly younger mean age of 32.53±8.80 years. Gender distribution showed that 70% of the patients in Group 1 were male, compared to 56.7% in Group 2. The majority of patients in both groups were labourers, accounting for 63.3% in Group 1 and 53.3% in Group 2. Regarding the dominant hand, 53.3% of patients in Group 1 were right-handed, compared to 73.3% in Group 2.

Table 1: Distribution of various parameters among the two groups of study participants

Parameter	Group 1 (Anterograde approach)N=30	Group 2 (Retrograde approach)N=30	TotalN=60
Age			
Age (in years) Mean±S.D.	34.60±7.35	32.53±8.80	32.43±8.08
Gender			
Male n (%)	21 (70.0%)	17 (56.7%)	38 (63.3%)
Female n (%)	9 (30.0%)	13 (43.3%)	22 (36.7%)
Occupation			
Labourer	19 (63.3%)	16 (53.3%)	35 (58.3%)
House wife	3 (10.0%)	4 (13.3%)	7 (11.7%)
Student	5 (16.7%)	7 (23.3%)	12 (20.0%)
Professional	2 (6.7%)	3 (10.0%)	5 (8.3%)
Businessman	1 (3.3%)	0	1(1.7%)
Dominating hand			
Left hand n (%)	14 (46.7%)	8 (26.7%)	22 (36.7%)
Right hand n (%)	16 (53.3%)	22 (73.3%)	38 (63.3%)
Mode of injury			
Assault by hard object n (%)	7 (23.3%)	3 (10.0%)	10 (16.7%)
Fall form 2w n (%)	8 (26.7%)	10 (33.3%)	18 (30.0%)
Fall of ground n (%)	1 (3.3%)	0 (0.0%)	1 (1.7%)
Fall of heavy object n (%)	2 (6.7%)	0 (0.0%)	2 (3.3%)
Fall on ground n (%)	4 (13.3%)	11 (36.7%)	15 (25.0%)
RTA 2w vs 2w n (%)	8 (26.7%)	6 (20.0%)	14 (23.3%)
Pattern of fracture			
Oblique	15 (50%)	15 (50%)	30 (50.0%)
Transverse	10 (33.3%)	11 (36.7%)	21 (35.0%)
Spiral	4 (13.3%)	4 (13.3%)	8 (13.3%)
Comminuted	1 (3.3%)	0 (0.0%)	1 (1.7%)
Implant removal at			
5 weeks n (%)	7 (23.3%)	5 (16.7%)	12 (20%)
6 weeks n (%)	17 (56.7%)	10 (33.3%)	27 (45%)
7 weeks n (%)	3 (10%)	11 (36.7%)	14 (23.3%)
8 weeks n (%)	1 (3.3%)	2 (6.7%)	3 (5%)
9 weeks n (%)	1 (3.3%)	1 (3.3%)	2 (3.3%)
10 weeks n (%)	1 (3.3%)	1 (3.3%)	2 (3.3%)
Radiological union at			
4 weeks n (%)	6 (20%)	5 (16.7%)	11 (18.3%)
5 weeks n (%)	13 (43.3%)	2 (6.7%)	15 (25%)
6 weeks n (%)	7 (23.3%)	9 (30%)	16 (26.7%)
7 weeks n (%)	3 (10%)	13 (43.3%)	16 (26.7%)
8 weeks n (%)	1 (3.3%)	1 (3.3%)	2 (3.3%)
Complications			
Stiffness n (%)	6 (20%)	9 (30%)	15 (25%)
Pin irritation n (%)	3 (10%)	2 (6.7%)	5 (8.3%)
Shortening n (%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Malunion n (%)	1 (3.3%)	0 (0.0%)	1 (1.7%)
No complications n (%)	20 (66.7%)	19 (63.3%)	39 (65%)
TAM compared to normal hand (in percentage)			
50-69 n (%)	6 (20%)	8 (26.7%)	14 (23.3%)
70-84 n (%)	10 (33.3%)	16 (53.3%)	26 (43.3%)
85-100 n (%)	14 (46.7%)	6 (20%)	20 (33.3%)
Total	30 (100%)	30 (100%)	60 (100%)

The mode of injury varied, with fall from two-wheelers being the most common cause in both groups (26.7% in Group 1 and 33.3% in Group 2). Fracture patterns were similar across both groups, with 50% of fractures being oblique. 56.7% of patients in Group 1 had implants removed at 6 weeks, compared to 36.7% in Group 2 who had it removed at 7 weeks. Radiological union was achieved in 43.3% of Group 2 patients by the 7th week, and in Group 1 by 5 weeks. Complications were relatively low across both groups, though Group 2 had a higher incidence of stiffness (30%) compared to Group 1 (20%). 46.7% of patients in Group 1 had TAM scores between 85-100%, while Group 2 had a higher percentage (53.3%) within the 70-84% range, indicating slightly better overall motion in Group 1. Table 2 compares the grip strength and Visual Analog Scale (VAS) scores between the two groups. At 6 weeks postoperatively, the mean grip strength in Group 1 was 19.87±4.01, significantly higher than the 14.06±4.17 in Group 2 (p-value<0.0001). At 12 weeks, Group 1 maintained higher grip strength (81.29±5.39) compared to Group 2 (74.48±6.51); (p-value <0.0001). The pre-operative VAS scores were similar between the groups, with no significant difference (p=0.053). However, at 2 weeks postoperatively, Group 1 reported significantly lower pain levels (VAS 3.98±0.94) compared to Group 2 (VAS 4.97±0.98); p-value=0.0002. This trend continued at 6 weeks, where Group 1 had a VAS score of 1.28±0.63 compared to 1.96±0.57 in Group 2 (p-value <0.0001). By 12 weeks, the VAS scores between the groups were not significantly different (p=0.197), suggesting similar pain levels at this later stage of recovery. These findings suggest that the anterograde approach might provide better grip strength and lower pain levels in the earlier postoperative period compared to the retrograde approach.

Table 2: Comparison of grip strength and VAS score among the two groups of study participants

Parameter	Group 1 (Anterograde approach)N=30Mean±S.D.	Group 2 (Retrograde approach)N=30Mean±S.D.	t-test value	p-value
Grip strength				
Grip strength 6 weeks	19.87±4.01	14.06±4.17	5.501	<0.0001*
Grip strength 12 weeks	81.29±5.39	74.48±6.51	4.413	<0.0001*
VAS score				
VAS Pre Operative	9.67±0.61	10.03±0.79	1.976	0.053
VAS 2 weeks	3.98±0.94	4.97±0.98	3.993	0.0002*
VAS 6 weeks	1.28±0.63	1.96±0.57	4.384	<0.0001*
VAS 12 weeks	0.15±0.43	0.29±0.40	1.306	0.197

*P-value significant

Discussion

Various internal fixation methods for metacarpal fractures are available, but the primary goals of treatment remain the same: restoring articular anatomy, ensuring stable fracture fixation, correcting angular or rotational deformities, and rapidly restoring mobility and function.

Although plating has been effective, it has been associated with complications such as soft tissue trauma and postoperative fibrosis, as highlighted in numerous studies. Kirschner wires (K-wires) have been shown to provide a safer alternative for reducing and stabilizing metacarpal fractures, although they can lead to issues such as impingement and insufficient functional stability. Foucher G [9] introduced the technique of using multiple K-wires, known as "bouquet" osteosynthesis, which is based on Ender's flexible intramedullary pinning. In our study, we modified this approach by using a single pin of adequate diameter (1.5mm, 1.8mm, or 2mm), pre-bent to provide elastic support. This method achieves three-point fixation, offering sufficient stability to allow early mobilization. The minimal soft tissue dissection and avoidance of periosteal stripping in our approach encourage abundant periosteal callus formation, which facilitates fracture healing. Additionally, this procedure is straightforward, reduces operating time, limits radiation exposure, and can be performed as a day-case surgery, thereby lowering hospital costs. However, the pinning technique is not without drawbacks, such as lack of absolute stability, wire migration, impingement of soft tissues, pin site problems, infection, and the need for implant removal. Foucher G [9] recommended leaving a sufficient length of wire exposed for easier secondary removal, a practice we also followed to monitor pin migration and manage pin sites more effectively, reducing the risk of infection. Our approach was to leave the pins on the skin surface, preventing soft tissue impingement and facilitating easier pin site care. Additionally, we employed a single thicker K-wire, which provided adequate stability and allowed for early passive range of motion exercises. Mohammed R et al. [10] also used a single K-wire for metacarpal fractures but directed the wire differently from our approach, which involved both anterograde and retrograde intramedullary pinning. In our study, we used non-locking pins, unlike the approach in the study by Orbay J [11], which utilized locking pins with a sleeve. We initiated early range of motion exercises immediately after fixation, in contrast to Kim JK et al.'s [12] study, where immobilization lasted up to 5 weeks. To enhance functional outcomes, we began with assisted finger and wrist mobilization, followed by unassisted movements and ball-squeezing exercises. In our study, the incidence of metacarpal fractures was higher among males, with 73.3% in the anterograde group and 66.7% in the retrograde group. This male predominance is consistent with other studies, such as Stanton J S et al [13] who reported a male-to-female (M: F) ratio of 4:1, Mohammed R et al. [10] (6:1), Margić K [14] (6.7:1), and Chammaa RH et al. [15] (9:1). The mean age of patients in our study was 35.79 years in the anterograde group and 31.03 years in the retrograde group. This aligns with findings from Stanton J S et al [13] (mean age=31 years), Omokawa S et al [16] (38 years) and Reddy PK and Javali V [17] (34 years), indicating that metacarpal fractures are most common in young adults. In our study, the most common mode of injury was a fall on the ground (33.3%), followed by road traffic accidents involving two-wheelers (23.3%). This differs from Stanton J S et al [13], who found road traffic accidents (RTA) to be the leading cause in 40% of cases, followed by home-related injuries (28%). Similarly, Gupta R et al. [18] and Feehan LM, Sheps SB [19]. reported RTA as the most frequent cause of hand fractures, accounting for 60% and 48% of cases, respectively. In contrast, Reddy PK and Javali V [17] observed a broader distribution, with 33.33% of injuries due to punching, 26.66% from RTAs, and 20% each from sports activities and falls. Our study demonstrated that the mean union time was 5.21 weeks in the anterograde group and 6.89 weeks in the retrograde group. These findings align with studies by Rhee SH et al [20] and Harris AR et al [21], who reported average union times of 5.6 weeks and 5 weeks, respectively. However, Roth JJ, Auerbach DM [22] found a slightly longer average union time of 7 weeks; Singh VJS [23] observed it to be 7.2 weeks and, Omokawa S et al [16] reported it to be 8 weeks, which corresponds more closely with our retrograde group. In terms of fracture patterns, our study found that 46.6% of fractures were oblique, and 40% were transverse, with spiral and comminuted fractures making up 11.6% and 1.6%, respectively. These results are consistent with Gupta R et al. [18] who found that 53.1% of fractures were transverse and 45% were oblique or spiral. The majority of fractures in our study occurred on the dominant side (53.3%=anterograde group and 73.3%=retrograde group), a finding supported by Stanton J S et al [13], who observed that 65% of injuries occurred in the dominant hand, and by Khan W, Fahmy N [24] and Anakwe RE et al [25] who reported a similar distribution. Regarding the TAM score, 46.7% of anterograde group had TAM scores between 85-100%, while retrograde group had a higher percentage (53.3%) within the 70-84% range, indicating slightly better overall motion in anterograde group. This result is comparable to the study by She Y, Xu Y [26], who found that the mean total active motion (TAM) was 270°, with excellent functional outcomes in the majority of cases. Aly T [27] also reported that 61.9% of patients had excellent results using the TAM for functional outcome assessment. The VAS pain score in our study decreased significantly from preoperative levels to follow-up at 6 and 12 weeks, with the anterograde group showing a more substantial reduction in pain. This is in line with the findings of Kim JK et al [12], who reported lower median VAS scores in the anterograde group compared to the retrograde group. In terms of complications, 76.6% of patients in the anterograde group and 70% in the retrograde group experienced no complications. Stiffness was the most common complication, affecting 16.7% of patients in the anterograde group and 23.3% in the retrograde group, consistent with findings from Aski B, Bhatnagar A [28] and She Y, Xu Y [26], who reported complications such as skin irritation, nerve injuries, and joint stiffness. Singh VJS [23] reported infection and stiffness, while Aly T [27] observed complications ranging from minor infections to significant deformities and stiffness. Conversely, Reddy PK and Javali V [17] reported no major complications, with patients generally satisfied with their outcomes. 46.4% of patients in the anterograde group achieved excellent results, compared to 23.4% in the retrograde group. Our findings suggest that the modified technique used in our study, particularly the single K-wire approach with early mobilization, provides favorable outcomes with fewer complications compared to traditional methods, as also noted by Singh VJS [23] and Aly T [27].

Conclusion

Anterograde intramedullary percutaneous pinning presents a viable alternative as it is a simple, cost-effective technique that spares the joints and minimizes complications. This method facilitates maximal functional recovery, reduces joint stiffness, and promotes early recovery compared to retrograde pinning. It is particularly effective for managing transverse or short oblique metacarpal fractures, which typically heal within 6-8 weeks. The procedure, performed under wrist or supraclavicular block, is associated with minimal postoperative pain, shorter hospital stays, and reduced operative time compared to open reduction and internal fixation with miniplates and screws. However, timely intervention is crucial, given the close relationship between hand form and function; delays can lead to stiffness, malunion, and compromised functional outcomes.

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