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Evaluating the Efficacy and Long-Term Impact of Proximal Fibular Osteotomy as a Treatment Option for Knee Osteoarthritis

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KEYWORDS

Proximal Femoral Osteotomy (PFO), Knee Osteoarthritis (OA), Visual Analogue Scale Score (VAS), Oxford Knee Score (OKS), Medial Knee Joint Space

ABSTRACT:

Background: Knee osteoarthritis (OA) is a prevalent and debilitating musculoskeletal condition that significantly impacts the quality of life for millions of individuals worldwide. Proximal fibular osteotomy (PFO) has emerged as a promising surgical intervention aimed at alleviating pain and improving function in patients with knee OA.

Methods: The 30 cases diagnosed with medial compartment osteoarthritis knee that met the inclusion criteria were treated with proximal fibular osteotomy at the Department of Orthopaedics in a Tertiary care Hospital, after obtaining the appropriate consent and ethical committee approval. We examine various aspects of PFO, including patient selection criteria, surgical techniques, post-operative rehabilitation protocols, and key outcome measures. Additionally, we discuss the reported clinical outcomes, radiological changes, and patient-reported improvements associated with PFO.

Results: Patients in the study, range between 41 - 50 years, the majority of cases were male 17 cases (56.66 %) and the remaining were female 13 cases (43.34%), indicating a male predominance. The right Limb was involved in 18 cases (60 %) and the left limb was involved in 12 cases (40 %). Medial joint space increased in 18 cases, decreased in 3 cases, and remained unchanged in 9 cases. Varus angle decreased in all cases and became zero in 5 cases (16.66 %). The maximum correction in varus angle was 8° and the minimum correction in varus angle was 3°. VAS Score decreased in all cases and became zero in 9 cases (30 %). The maximum improvement in VAS Score was 6 and there was a worsening in pain in 1 case with an increase in VAS score by 1. Oxford's knee Score increased in all cases. The maximum increase in Oxford knee Score was 12 & minimum increase in Oxford knee Score was 1.

Conclusion: The Proximal fibular osteotomy appears to be a promising therapeutic option for knee OA, offering substantial pain relief and functional benefits. Nonetheless, further research is needed to establish standardized protocols, refine patient selection criteria, and elucidate the long-term effects of this procedure. A collaborative effort between orthopaedic surgeons and researchers is essential to optimize the utility of PFO in managing knee OA and enhance patient outcomes.

Introduction:

Osteoarthritis of the knee is a degenerative disease that affects the articular cartilage. It causes discomfort, deformity, disability, and a decrease in the range of motion of the affected joint [1, 2, 3]. Numerous factors, including old age, female gender, overweight and obesity, knee injury, repetitive use of joints, bone density, muscle weakness, and joint laxity, might contribute to the development of joint osteoarthritis, especially in the weight-bearing joints [4,5]. The demographics most typically

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impacted are those who are male and over the age of 45. Age, being a woman, being overweight or obese, leading a sedentary lifestyle or making other lifestyle changes, and engaging in work-related activities are all risk factors for knee osteoarthritis.

Three compartments make up the knee joint: medial, lateral - tibiofemoral, and patellofemoral. Knee osteoarthritis may affect any of these compartments individually or in any combination, but the relative frequency of each type varies significantly. Knee osteoarthritis can be categorized as a single, dual, or tri-compartmental condition. One-third of instances of osteoarthritis knee are unilateral, with medial compartmental osteoarthritis making up one-third of these occurrences. Due to its intricate anatomy, the knee joint, which carries the bulk of the human body's weight, is vulnerable to osteoarthritis [1].

Although it has been shown that the medial compartment supports 60% to 80% of the weight in healthy knees, the exact reason for this unbalanced load distribution remains unknown [6].

The load-bearing axis of the lower limb can be shown as a line connecting the centres of the femoral head and ankle joint. In a varus (bow-leg) knee, this line travels medially to the centre of the knee, generating stress over the medial tibiofemoral compartment. Recent studies on the development of primary knee OA have linked alignment to the condition's progression [7,8,9,10,11]. It was found that alignment affected intermediate tibiofemoral OA knees more than mild OA knees, possibly because more diseased knees are more sensitive to changes in load distribution [12]. This suggests that any alignment-related impact on the probability of developing incident knee OA is less likely and possibly more challenging to detect than the effect on progression.

Analgesic medications, physical therapy, intra-articular visco-supplementation agents, and intra-articular infusion of corticosteroids or platelet-rich plasma are among the non-operative treatments for knee arthritis. Total knee replacement will be the best option for senior patients with tri-compartmental osteoarthritis of the knee [13]. The only remaining therapeutic choices for addressing knee osteoarthritis in younger people who solely have a varus deformity and the medial compartment of the knee joint are HTO, high tibial osteotomy, and Unicondylar knee replacement [14].

These surgeries come with their own unique set of risks, a protracted postoperative recovery period, and limitations on activities or weight bearing. Therefore, a procedure that is simple to perform, simple to replicate, offers excellent functional outcomes, is linked to a shorter recovery period, and improves the quality of life for the affected individuals is required. According to previously published and current research, PFO, which is a relatively new and novel technique in this situation, is quite beneficial in the management of medial compartment arthritis of the knee [15].

The authors hypothesize that the non-uniform settlement and bilateral degeneration of the plateau may be caused by the fibula-soft tissue complex, which mediates lateral support for the osteoporotic tibia [16,17]. This notion is supported by previous imaging and clinical research. The usual load distribution may migrate farther medially to the medial plateau as a result of knee varus and accelerated medial compartment OA of the knee joint. By applying this reasoning, the authors have treated the medial compartment OA of the knee joint and reduced the increasing loading stress. They did this by performing a proximal fibular osteotomy. By this notion, we created a technique for transecting a 20-millimeter section of the fibular shaft precisely 7–8 cm below the fibular head. To relieve intense medial compartment pressure and gradually realign the axis of weight bearing on the knee, is thus done.

Material and Methods:

This research was done at the Tertiary Medical College & Hospital's Department of Orthopaedics. June 2020 to May 2022 served as the study's timeframe. In this investigation, 30 cases of medial compartment osteoarthritis of the knee were included. Proximal fibular osteotomy was used to treat them.

Inclusion Criteria:

1. Patient diagnosed with medial compartment osteoarthritis knee.
2. Age of patients more than 30 years.
3. A varus of no more than 15 degrees.
4. Fixed flexion deformity of 15 degrees or less.

Exclusion Criteria:

1. Bi & Tri compartmental osteoarthritis
2. Infective arthritis
3. Rheumatoid arthritis
4. Post-traumatic arthritis

Statistical analysis:

The Data analysis was completed using Microsoft Excel. The Chi-square test was used to compare the groups of the categorical data, which were given as percentages. The mean and standard deviation of the quantitative data were displayed, and students' t-tests were used to compare them.

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If the probability was less than 0.05, it was deemed significant.

Preoperative Evaluation:

A complete clinical examination and in-depth history collection were performed. conventional weight-bearing Antero-posterior and lateral images of two orthogonal plain radiographs of the afflicted knee joint were taken. A standard pre-anaesthesia examination was carried out. Visual Analogue Scale (VAS) was used to assess the pain scale. Using a modified version of the Oxford Knee Score (OKS) method, the functional status of the patients included was evaluated.

Operative Procedure:

The proximal fibular osteotomy treatment was carried out under spinal anaesthesia on a radiolucent operating table in a sterile environment. Patients were positioned supine with their knees flexed 45 degrees, and measurements and the amount of osteotomy were predetermined (**Figure 1)**. A 2.5 cm long skin incision was created starting 6.5 cm distally from the fibula head (**Figure 2)**. After carefully retracting the soleus and peroneus muscles, fingers were used to do blunt dissection. The shaft's periosteum was removed using scrapers. Drill holes were used to mark the osteotomy level before more osteotomy was performed (**Figure 3)**. Osteotomy was performed using an oscillating saw (**Figure 4)**. The ends of the osteotomized piece were smoothed before removal (**Figure 5)**. Nylon interrupted sutures were used to repair the incisions, and a compressive dressing was placed.

Post-Operative Care and Rehabilitation:

We searched for immediate post-operative problems such as vascular injury, compartment syndrome, neurological damage, and fat embolism. Following surgery, an intravenous antibiotic treatment was maintained for three days. The oral antibiotics continued for another two days. Removal of staples or sutures took place between the 12th and 15th postoperative day. On the first post-operative day, vigorous ankle and toe motions and knee mobilization were resumed as long as the patients were comfortable and pain-free. Postoperative evaluations were performed on the first, second, sixth, and twelfth weeks. Both the Oxford Knee Score (OKS) method and the Visual Analogue Scale (VAS) scoring method were used for the evaluation.

Results:

In the present study, the majority of cases were male, comprising 17 cases (56.66%), while the remaining 13 cases (43.34%) were female. This resulted in a male-to-female ratio of 1.3:1. The age distribution of the cases showed that the majority fell within the 41-50 years age group, accounting for 13 subjects (43.33%). The next most common age groups were 30-40 years with 10 subjects (33.33%) and 51-60 years with 7 subjects (23.34%). The mean age for all subjects was 44.27586 ± 06.922513 years. Notably, the highest number of cases in the 41-50 age group was 13 cases (43.33%) with 7 males and 6 females, followed by the 30-40 age group with 10 cases (33.33%) comprising 7 males and 3 females. A similar pattern was observed in the 51-60 age group with 7 subjects (23.34%) having 3 males and 4 females.

Regarding occupational backgrounds, the study found that the maximum number of cases came from an agriculture background, accounting for 9 cases (30%), followed by daily wage workers and government service personnel, both with 6 cases (20%) each. Housewives constituted 5 cases (16.67%), and business professionals made up 4 cases (13.34%). In terms of residential backgrounds, the majority of cases were from rural areas, totalling 24 cases (80%), while the remaining cases were from urban backgrounds, making up 6 cases (20%).

The study also examined limb involvement, revealing that the right limb was affected in 18 cases (60%), while the left limb was involved in 12 cases (40%). Further analysis showed that the medial joint space increased in 18 cases, decreased in 3 cases, and remained unchanged in 9 cases. The maximum increase observed in the medial joint space was 0.5 mm, and the maximum decrease was 0.1 mm. The mean medial joint Space at the Pre-OP was 2.9700 ± 0.3816 mm, The mean medial joint space did not change immediately after Post OP & follow-up on 2nd Week. The mean medial joint space slightly increased on the 6th week of follow-up 3.0700 ± 0.4850 mm and also increased slightly on the 12th week of follow 3.1233 ± 0.5282 mm (**Table. 1)**.

In terms of varus angle correction, all cases saw a decrease, with 5 cases (16.66%) achieving a complete correction to zero. The maximum correction in varus angle was 8°, and the minimum correction was 3°. The study found that the mean varus angle at the preoperative stage was 9.933 ± 3.722°, which decreased slightly immediately after the surgery to 9.900 ± 3.772°. On the 2nd-week follow-up, it decreased to 7.900 ± 3.294° and significantly decreased on the 6th-week follow-up to 5.900 ± 3.417°, with a slight decrease also observed on the 12th-week follow-up to 4.733 ± 3.483° (**Table. 2)**.

Additionally, the study evaluated pain using the Visual Analog Scale (VAS) and found that VAS scores decreased in all cases, reaching zero in 9 cases (30%). The maximum

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improvement in VAS score was 6, and one case experienced an increase in pain, resulting in a VAS score increase of 1. The mean VAS score at the preoperative stage was 6.1333 ± 1.3069, remaining unchanged immediately after the surgery. However, on the 2nd-week follow-up, it significantly decreased to 4.1666 ± 1.4403, with further significant decreases on the 6th-week and 12th-week follow-ups to 3.0000 ± 2.0678 and 2.2000 ± 2.2803, respectively (**Table. 3)**.

In the study, the Oxford Knee Score (OKS) showed improvement in all cases, with the maximum increase being 12 and the minimum increase being 1. The mean OKS at the preoperative stage was 30.1666 ± 5.1399, increasing slightly after the surgery to 30.3000 ± 5.1067. Subsequently, the 2nd-week follow-up showed a significant increase to 32.6000 ± 5.2496, with further significant increases on the 6th-week and 12th-week follow-ups to 34.4333 ± 5.5066 and 35.8333 ± 6.1927, respectively (**Table. 4)**.

Lastly, the study reported complications in 4 cases (16.66%), with no complications observed in 26 cases (86.67%).

Discussion:

Knee osteoarthritis, one of the most common joint disorders, causes agonizing pain and immobility. Advanced osteoarthritis of the knee is successfully treated with TKA to lessen pain and improve knee function. Additionally, TKA is an expensive and difficult treatment, and some patients need a second revision. HTO, which attempts to improve alignment and delay the need for TKA, has historically been chosen by young patients with osteoarthritis of the medial compartment of the knee. Some downsides of HTO include a lengthy recovery period before full weight bearing, the potential for non-union or delayed union, peroneal nerve paralysis, and wound infection.

Proximal fibular osteotomy is the surgical procedure of choice for knees with medial compartmental osteoarthritis in particular circumstances. The main benefit of the procedure is that it gives the patient unrestricted activity. Thus, an osteotomy is a suitable operation that in no way excludes a later total knee arthroplasty for patients whose jobs require strenuous activity or who want to continue playing sports.

Medial compartment arthritis in knee joints is brought on by an age-related progressive increase in Varus. The lateral side is loosened by resecting a fibula segment, allowing the upper tibia to settle more favourably laterally. This causes the mechanical axis to shift towards neutral or valgus, which transfers loads from the knee's worn-out medial compartment to the more normal lateral compartment. Success with these knee-conserving techniques in a Varus-aligned knee cannot be anticipated unless alignment is returned to normal. As a result, the PFO's position may change again and grow in significance in the future.

Patients with knee MCOA underwent PFO in this series. 30 knees in all were operated. The findings of the present study and findings from other studies (Qin et al., kai lu et al., Liu B et al., Wang X et al., Zou G et al., Nie Y et al., Yang ZY et al.) are also briefly mentioned (**Table 5**), providing additional context on the improvement in knee symptoms, function, clinical satisfaction, and reduced pain observed in patients who underwent a similar surgical procedure.

Table 5: Comparison of Radiological and functional Outcomes

Study	**Functional Outcome & Radiological Outcome**
Present Study	• Medial joint space increased in 18 cases decreased in 3 cases and remains unchanged in 9 cases. The maximum increase in medial joint space was 0.5 mm & maximum decrease in medial joint space was 0.1 mm. • Mean medial joint Space at the Pre-OP was 2.9700 ± 0.3816 mm, The mean medial joint space did not change immediately after Post OP & Follow up on 2nd Week. The mean medial joint space slightly increased on the 6th week of follow-up 3.0700 ± 0.4850 mm and also increased slightly on the 12th week of follow-up 3.1233 ± 0.5282 mm. • Varus angle decreased in all cases and became zero in 5 cases (16.66 %). The maximum correction in varus angle was 8° and the minimum correction in varus angle was 3°. • Mean Varus Angle at the Pre-OP was 9.933 ± 3.722°, the mean varus angle decreased slightly, immediately after Post OP was 9.900 ± 3.772°, on 2nd Week follow-up 7.900 ± 3.294°. The Mean Varus Angle decreased significantly on the 6th week of follow up 5.900 ± 3.417° and also decreased slightly on the 12th week of follow up 4..733 ± 3.483°.

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	• VAS Score decreased in all cases and became zero in 9 cases; 30 %. The maximum improvement in VAS Score was 6 and there was a worsening in pain in 1 case with an increase in VAS score by 1. • VAS Score was 6.1333 ± 1.3069, the Mean VAS Score did not change immediately after Post OP. On 2nd Week's follow-up, it decreased significantly to 4.1666 ± 1.4403. The Mean VAS Score significantly decreased on the 6th week of follow-up at 3.0000 ± 2.0678 and also decreased slightly on the 12th week of follow-up at 2.2000 ± 2.2803. • OKS Score increased in all cases. The maximum increase in Oxford knee Score was 12 & minimum increase in Oxford knee Score was 1. • Mean Oxford knee Score at the Pre-OP was 30.1666 ± 5.1399, The Mean Oxford knee Score increased slightly after Post-OP OP at 30.3000 ± 5.1067. On 2nd Week Follow up Oxford's knee Score increased significantly to 32.6000 ± 5.2496. The Mean Oxford knee Score significantly increased on the 6th week of follow-up 34.4333 ± 5.5066 and also increased slightly on the 12th week of follow-up 35.8333 ± 6.1927.
Qin et al. [18]	• The 36-month follow-up period saw a significant improvement in knee symptoms and function ($p<0.001$).
kai lu et al. [19]	• According to the VAS and HSS scores, patients showed significant improvements from treatment more than 24 months later. No patient required conversion to another surgery during follow-up since there was no radiographic indication of Ahlbäck classification osteoarthritis progression or fibular bony union.
Liu B, et al. [20]	• According to the study's findings, the preoperative KSS clinical score was the only independent variable linked to patients' clinical satisfaction; as a result, patients with less severe disease are more likely to experience successful outcomes. • For every point a rise in the clinical portion of the KSS score, the probabilities of clinical satisfaction increased by roughly 13.4%. • The HKA angle and settlement value were simple to assess and less influenced by subjective considerations. Therefore, these two criteria could serve as the primary foundation for choosing patients. • The degree of non-uniform-settlement of the tibial plateau was determined using settlement value as a factor. The impact of lateral fibula support is greater and PFO has a better result when the settlement value is bigger. These results revealed a close relationship between the non-uniform-settlement hypothesis and PFO in the management of KOA.
Wang X, et al. [21]	• A notable difference between the VAS score, the pain in the medial joint, and the improvement in the medial joint space
Zou G, et al. [22]	• When compared to the HTO group, the PFO group's full weight-bearing time was much shorter, while the operation's duration, bleeding volume, and drainage volume all significantly decreased ($p<0.05$). • When comparing the PFO group to the HTO group, the pain VAS and FTA dramatically decreased, and the knee joint's JOA score significantly raised ($p<0.05$).

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	• The PFO group had a significantly reduced incidence of problems than the HTO group ($p<0.05$).
Nie Y, et al. [23]	• Significant reduction in VAS pain score ($p<0.001$). • The HSS score increased significantly ($p<0.001$), indicating enhanced function. • There is a noticeable difference following PFO.
Yang ZY, et al. [24]	• The mean FTA and lateral joint space at final follow-up were, respectively, 179.4°±1.8° and 6.9±0.7 mm, which were considerably lower than the data assessed preoperatively ($p<.001$). • Compared to preoperative radiographs, the medial joint space was broader and the lateral joint space was smaller. • At the final follow-up, the mean VAS score and interquartile range were each 2.0, which was considerably lower than the preoperative data (7 and 1.0, respectively; $p<.001$;

Conclusion:

Proximal Fibular Osteotomy may significantly lessen medial compartment osteoarthritic knee pain and speed up the healing of functional knee joints. In patients with medial compartment OA of the knee joint, it is a safe, simple, and effective alternative to High Tibial Osteotomy (HTO) that may help patients avoid or at least delay the need for total knee arthroplasty. Caution must be exercised to avoid causing any nerve damage. Long-term research is necessary for the approach to become widely accepted.

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Tables and Charts

Table. 1: Mean Medial Joint Space (n = 30)

S. No.	Condition	Mean Medial Joint Space (mm)	Mean Standard Deviation
1.	Pre-OP	2.9700	± 0.3816
2.	Immediate Post OP	2.9700	± 0.3816
3.	2nd Week	2.9700	± 0.3816
4.	6th Week	3.0700	± 0.4850
5.	12th week	3.1233	± 0.5282

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Table. 2: Mean Varus Angle (n = 30)

S. No.	Condition	Mean Varus Angle (°)	Mean Standard Deviation
1.	Pre-OP	9.933	± 3.722
2.	Immediate Post OP	9.900	± 3.772
3.	2nd Week	7.900	± 3.294
4.	6th Week	5.900	± 3.417
5.	12th week	4.733	± 3.483

Table. 3: Mean VAS Score (n = 30)

S. No.	Condition	Mean VAS Score	Mean Standard Deviation
1.	Pre-OP	6.1333	± 1.3060
2.	Immediate Post OP	6.1333	± 1.3060
3.	2nd Week	4.1666	± 1.4403
4.	6th Week	3.0000	± 2.0678
5.	12th week	2.2000	± 2.2803

Table. 4: Mean Oxford knee Score (n = 30)

S. No.	Condition	Mean Oxford knee Score	Mean Standard Deviation
1.	Pre-OP	30.1666	± 5.1399
2.	Immediate Post OP	30.3000	± 5.1067
3.	2nd Week	32.6000	± 5.2496
4.	6th Week	34.4333	± 5.5066
5.	12th week	35.8333	± 6.1927

Figures

Figure. 1: Patient placed in a supine with the knee flexed 45 degrees and the level of osteotomy is pre-determined and measurements marked.

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Figure. 2: Skin incision of length 2.5 cm, made from 6.5 cm distal from the head of the fibula.

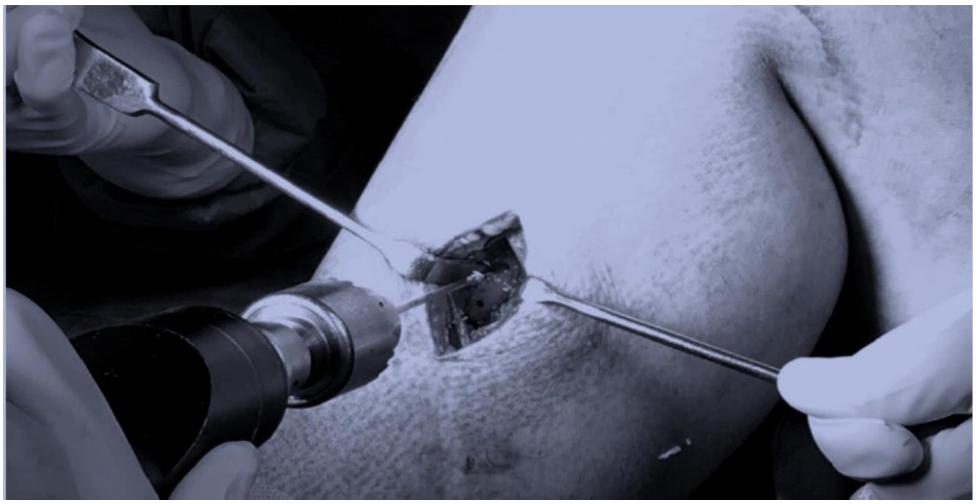

Figure. 3: The osteotomy level is marked using drill holes.

Figure. 4: The oscillating saw is used to make osteotomy.

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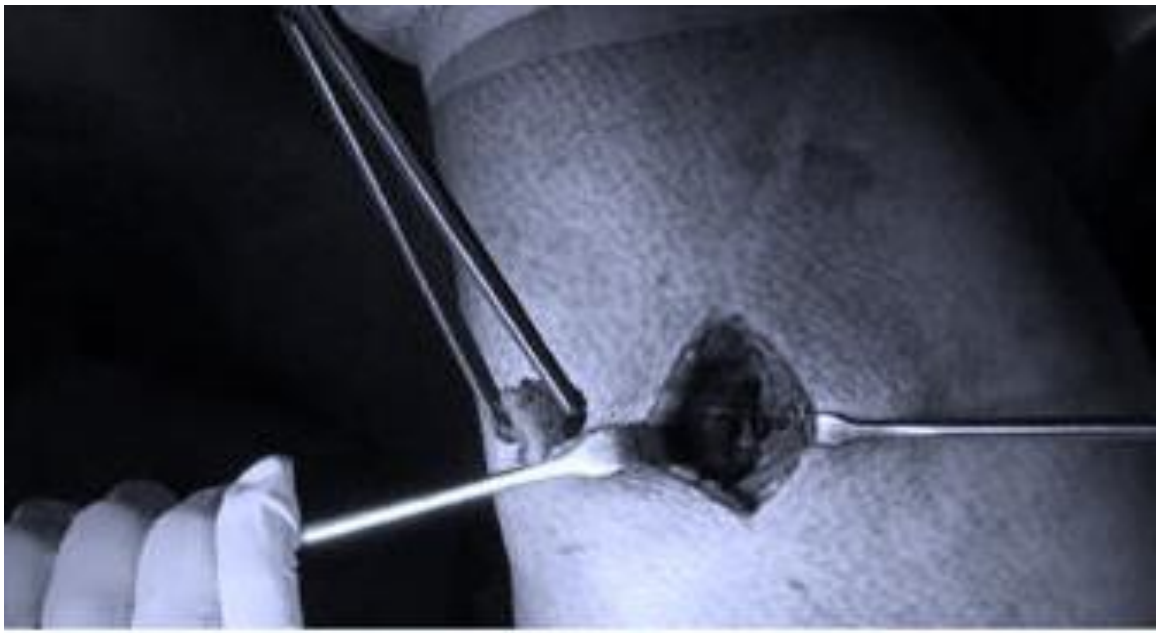

Figure. 5: The osteotomized fragment (1.5 cm) is removed and ends smoothed.

Figure. 6: Pre-operative and Post - Operative X-ray image.