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ORIGINAL ARTICLE

Functional Outcome of Hooked/Locked Patellar Plate Versus Tension Band Wiring in Treatment of Patellar Fractures: A Comparative Case Series

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Abstract

Background/Aim: Patella fractures significantly compromise the knee joint function and usually require surgical fixation to restore the knee extensor mechanism. Tension band wiring (TBW) and locked patellar plate (LPP) are widely used surgical methods for the fixation of these fractures. Within 12-months post-surgery functional outcome using Lysholm knee score (LKS) as primary outcome and visual analogue score (VAS) were compared, degree of knew flexion, complication and radiographic union as a secondary outcome.

Methods: Prospective comparative case series consecutively enrolled 24 patients with patella fractures allocated by chosen fixation method into: TBW (12/24) group and hooked part of the locked patellar plate (H/LPP) group (12/24). Patients' demographics, fractures criteria, 12-months LKS and 12-month VAS were recorded in addition to other secondary parameters (operative time, radiographic union, complication).

Results:. At 1-year follow-up, mean LKS was significantly higher in H/LPP group vs TBW group (89.4 ± 4.8 vs 79.2 ± 6.5; p = 0.0016). The VAS scores were lower in H/LPP than TBW group (1.8 ± 0.9 vs 3.1 ± 1.2; p = 0.0042). Radiographic union time showed trend in H/LPP vs TBW group (10.3 ± 1.5 vs 11.2 ± 1.8 weeks; p = 0.125). Complications occurred in 4 (33.3 %) of TBW group (one wire breakage, 2 patients with k-wire prominence and superficial infection) while only one patient (8.3 %) had implant related discomfort as a complication which resolved spontaneously was seen in LPP group, p = 0.093.

Conclusion: H/LPP fixation demonstrated superior functional outcomes, lower pain scores and fewer complications compared to TBW in the treatment of patella fractures, making it a recommendable option for patellar fracture management.

Key words: Patella fracture; Tension band wiring; Hooked/locked patellar plate; Lysholm knee score; Visual analogue scale; AO/OTA fracture and dislocation classification.

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Introduction

The patella or knee cap is the largest sesamoid bone in the body and an important part of the knee extensor mechanism because it acts as a pivot for forces directed during knee extension.[1] Patella fractures represent about 1 % of all fractures. Males are more commonly affected than

females and are frequently associated with other injuries.[2] The type of fracture that results is determined by the mechanism of injury, either direct trauma to the anterior aspect of the knee joint or indirect injury resulting from eccentric muscle contraction and rapid knee flexion against a contracted quadriceps muscle.[3, 4] The goal of surgical treatment is to restore the normal congruity of the knee joint, specifically the extensor mechanism, to allow for early stable range of motion and to prevent long-term disability.[5, 6] Despite various methods of fixation of patella fractures, traditionally, tension band wiring (TBW) remains a standard surgical procedure in most departments of orthopaedic surgery worldwide.[7]

TBW acts through converting the tensile forces across the fracture site into compression during knee flexion and this enhances bone healing.[8] However, this technique is associated with several complications, including loss of reduction, k-wire migration or breakage, extensor lag and soft-tissue irritation, especially in osteoporotic bone or comminuted fracture.[9] More recently, variable locked patella plating (LPP) systems (hook plates, mesh plates, rim plates, etc) have been utilised in the management of patella fractures, they enable the insertion of multiple screws into various fracture fragments, making them more likely to be used in the treatment of more complex and multi-fragmentary fracture patterns and provide rigid fixation with low risk of implant migration or irritation and patient can begin early range of motion exercise and weight bearing sooner.[10] Patella fractures are classified as 34 in the AO/ OTA classification that provides a universally accepted framework for categorising patellar fractures based on anatomical location and fracture pattern.[11] TBW had been known as the traditional fixating method for patellar fracture with its inherent complications, including hardware problems that urged for a second surgery.

On the other hand, the hooked part of the locked patellar plate (H/LPP) had offered improved stability and fewer implant-related complications. Since no study in our country had assessed these two approaches, the current study aimed to compare TBW versus H/LPP among patients with patellar fractures, 12 months post the operation, in terms of functional outcome. Secondary aim included analyses of pain post-surgery, degree of knew flexion, radiographic union, operation time and complication, with the goal of setting optimal fixation strategies to guide the surgical decision-making based on evidence-based data in the management of patella fractures.

Methods

This prospective comparative case series used consecutive sampling to enrol patients with patella fractures at Al-Yarmouk Teaching Hospital from February 2023 to August 2025. Those cases suffered from different types of patella fractures (closed, displaced transverse, or complex patellar fractures) and underwent surgical treatment.

Acute patella fractures cases who were initially evaluated to be eligible at the time when the study was conducted was (n = 28). Among them, four patients were excluded according to the predetermined exclusion criteria: one of them had open in patella and two of them had ipsilateral injury (one patient had ipsilateral femoral shaft fracture and another had ipsilateral tibial shaft fracture) and another patient was lost to follow-up before the 12-month assessment. The rest (n = 24) patients were fit for the inclusion criteria and were included in the study.

The patients were allocated into two surgery groups as based on the fixation method chosen by the operating surgeon depending on the fracture pattern (AO/OTA classification), level of comminution, quality and intraoperative viability of fixation and availability of implants. In this regard (n = 12/24) patients TBW and (n = 12/24) patients H/LPP fixation were applied.

Complete medical and surgical history was obtained and a full clinical systemic physical examination was performed. All patients were operated on within one week of trauma and were followed for at least 12 months. Data collected included: patients' demographic (age, gender, body mass index, smoking history and diabetes) and fracture details (side, type and cause of fracture). Surgical time needed for radiological union and how many achieved full union, goniometer for knee flexion, functional assessment evaluated by Lysholm functional knee score[12] and post-operative pain score (using VAS scores).[13]

The primary endpoint of study was LKS -12 months after surgery compared between the 2

fixation methods used. The secondary endpoint included:

- Pain level felt 12-months post the operation based on VAS;
- The degree of knee flexion 12-months post-the operation;
- Time of operation (min) and time to radiographic union (weeks);
- Post operative complications with 12-moths post the operation.
- Inclusion criteria were:
- Adults (18-60) presented with acute closed patellar fractures, within 7 days of the injury,
- Radiological patellar fractures that are suitable for surgical fixation either by TBW or L/HPP,
- Gave informed consent, enrolled and are willing to comply with the 1-year follow-up.
- Exclusion criteria were:
- Open patellar fractures or pathological fractures,
- polytraumatic patients with ipsilateral femur or tibia fracture or concomitant ligamentous knee injury,
- History of prior knee surgery on the affected side,
- Missing data or lost patient follow-up.

Surgical technique

1-TBW

All patients in the supine position received general or spinal anaesthesia, as determined by their assessment. After standard skin disinfectant and sterile dressing, a pneumatic tourniquet is usually applied. A longitudinal midline patella, fracture site exposed, cleaning of haematoma and anatomical reduction achieved, held temporarily with a clamp, two parallel K-wires (1.6-2.0 mm) from inferior to superior pole confirmed under fluoroscopy. Then, stainless-steel wire (18 gauge) was passed in an 8 shape or encircled around k-wires. K-wires were tightened and buried subcutaneously, a transverse K-wire in addition to two parallel K-wires in type C2 and C3 patellar fractures was added, as in (Figure 1: A-C). Wound irrigation, tourniquet removed, good haemostasis followed. Stability check and maintained reduction by passively flexing and extending the knee under fluoroscopy was done. Surgical site was closed in layers, followed by the application of a sterile dressing (Figure 2: A-C).

2-H/LPP

All patients in the supine position received general or spinal anaesthesia, as determined by their assessment. After standard skin disinfectant and sterile dressing, a pneumatic tourniquet was usually applied. A longitudinal midline patella, fracture site exposed, cleaning of haematoma and anatomical reduction achieved, held temporarily with clamp and K-wires confirmed under fluoroscopy. Low-profile, anatomically hooked part of the locked patellar plate (H/LPP) according to the patella size, the hooked engaged under the distal or proximal fragment, the seat plate was flushed to the anterior surface of the patella and the plate was fixed to the main fragment opposite the hooks using locking screw 3.5 mm inserted eccentrically to induce compression across the fracture. In type C2 and C3 patellar fracture, fixation of large and medium fragments anatomically by K-wires temporarily; or 1.5-2.0 mm of interfragmentary screws in variable angles accordingly and away from the fracture line, before applying a hooked plate to capture multi-

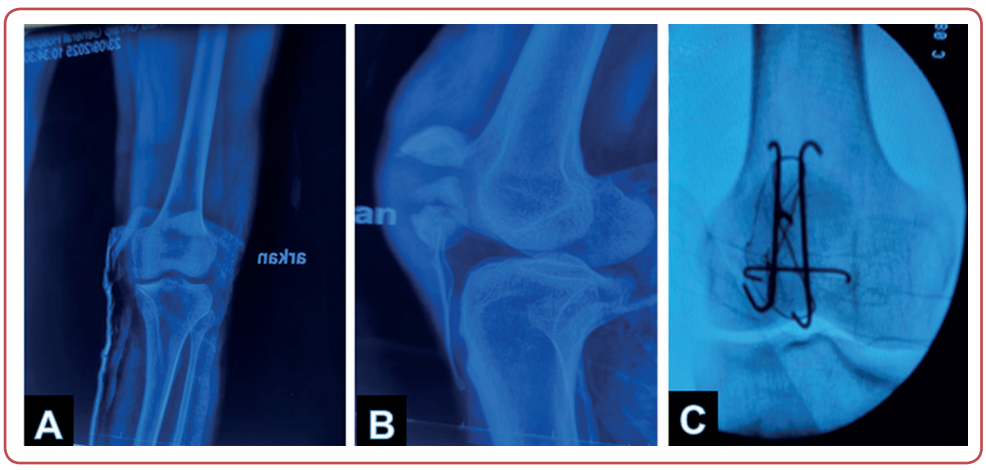

Figure 1: A 45-year-old male patient with 34-C3 patella fracture (A, B) treated by tension band wiring (TBW) with additional transverse K-wire (C)

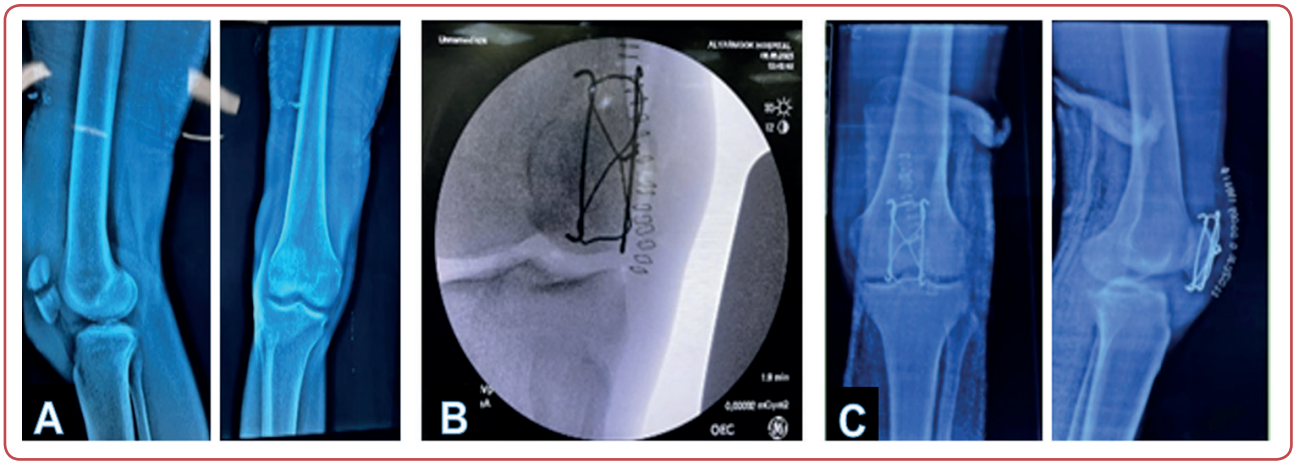

Figure 2: A 33-year-old female patient with a history of road traffic accident (RTA) treated by tension band wiring. AP and lateral views before operation fracture patella type 34-C1 (A), perioperative findings (B), postoperative fluoroscopy, AP and lateral views (C)

ple small pieces *en bloc* at once, then fluoroscopy to confirm reduction, articular congruity to confirm that no small fragment were displaced or gap, then stability was checked and maintained reduction by passively flexing and extend knee under fluoroscopy. Wound irrigation was performed, tourniquet removed, good haemostasis, close paratenon over the plat, then surgical site closed in layers, followed by the application of a sterile dressing as in Figure 3: A-E.

Post-operative protocol

Knee immobiliser by backslap was used for 1-2 weeks, accordingly to instructions and sterile dressing was changed after 2-7 days. Isometric exercise started after 48 hours. Sutures were removed after 10-15 days. Active range was as patients tolerated: 2nd-3rd weeks. Partial weight bearing immediately progressed to full according to radiological signs of healing and clinical symptoms, which increased gradually by 4-8 weeks.

All patients received ceftriaxone 1 g or vancomycin 1 g (if had B-lactam allergy) within 60 minutes before surgery and postoperative antibiotics given for first 24 h only (except in diabetic patients used for the first three days). Intravenous analgesia was given on the first day only and then followed by oral analgesia when required.

Follow-up: patients were asked to come for follow-up after 2 weeks, 1, 2, 3, 6 and 12 months from the time of surgery. At each follow-up, all patients were assessed clinically using Lysholm and VAS in addition to radiological union and knee flexion by goniometry.

Statistics

Post -hoc analysis with observed pooled standard deviation (SD) of 5.7 points showed a 80 % power; as type -1 error = 0.05 two tailed, to detect a 6.5 points LKS differences in 12-month follow up, which surpass the established minimal clinical-

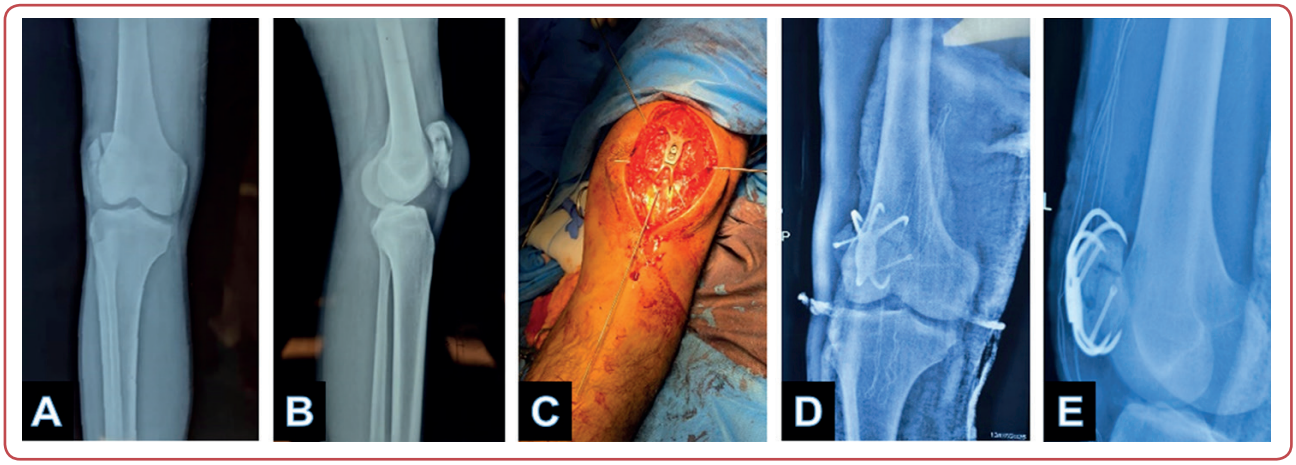

Figure 3: AP and lateral views (A, B) of a 38-year-old patient with a history of a fall from height showing type C3 patella fracture (C), patellar hooked plate fixation with interfragmentary screws after temporary fixation by K-wires (D) and immediate post-operative AP and lateral views (E)

ly important difference of 5- 8 points. This sampling size adhered with comparable surgical case series.[14]

Data were analysed using *SPSS version 25.0*; IBM Corp. NY USA. The information is displayed in the form of mean, SD for continual data and were compared using independent t-test. The categorial variables were presented as frequencies and analysed using Fisher's exact test. The primary end point was calculated by independent samples t-test with the report of mean differences alongside 95 % confidence interval (95 % CI) and a two tailed $\alpha = 0.05$. As for the secondary outcomes; they were analysed using independent t-test. In order to control family -wise error rate linked with multiple secondary comparisons Holm-Bonferroni sequential corrections were used, with the calculation of both adjusted and un- adjusted p-value and effect size report. A p-value < 0.05 was set as the level of significant for all tests.

Results

A total of 24 patients with patellar fracturs completed 12-month in this study, divided into two groups: 12 patients underwent fixation with TBW and 12 patients underwent fixation with H/LPP. The mean age was 41.3 ± 11.2 years in TBW vs 39.6 ± 10.7 years for H/LPP. The two groups were comparable with respect to baseline demographic primary criteria (gender distribution, fracture side and type, mechanism of injury) as well as associated comorbidities (smoking and diabetes status) as described in Table 1.

At one-year follow-up, the H/LPP group demonstrated significantly higher functional outcome with a mean LKS of 89.4 ± 4.8 vs 79.2 ± 6.5 in the TBW group; mean difference 10.2 points (95 % CI: 5.8-14.6), p = 0.002. This difference surpassed the minimal clinically importance difference of 5-8 points which confirmed the functional recovery with H/LPP.

The H/LPP group showed significantly lower VAS pain score 1.8 ± 0.9 vs 3.1 ± 1.2 with adjusted p-value of 0.012. Additionally, the final Mean range of knee flexion was significantly greater in the H/LPP group (125° ± 8°) compared with the TBW group (110 ± 10°; with adjusted p-value 0.010 at 12-months). However, the operation time

Table 1: Primary demographic characteristics of the study population

Variables	TBW group (n = 12)	H/LPP group (n = 12)	P -value
Age (years) (mean ± SD)	41.3 ± 11.2	39.6 ± 10.7	0.68*
Sex (M/F)	9M/3F	7M/5F	0.68*
BMI kg/m² (mean ± SD)	25.4 ± 2.3	24.9 ± 2.1	0.57*
Injured side, n (%)			
Right	7 (58.3 %)	6 (50.0 %)	0.77 ‡
Left	5 (41.7 %)	6 (50.0 %)	
Fracture type; n (%) based on AO/OTA			
34 C1 (Simple transverse)	7 (58.3)	6 (50.0)	
34 C2 (Comminuted 2 part)	4 (33.3)	4 (33.3)	0.75 ‡
34 C3 (Multifragmentary)	1 (8.3)	2 (16.7)	
Mechanism of injury			
Road traffic accident	8 (66.7)	6 (50)	
Fall from height	2 (16.7)	4 (33.3)	0.66 ‡
Direct trauma	2 (16.7)	2 (16.7)	
Current smoker; n (%)	3 (25.0)	4 (33.3)	0.68 ‡
Diabetes mellitus; n (%)	3 (25.0)	2 (16.7)	0.62 ‡

*‡: Analysis was conducted via fisher exact test; *: analysis was done using independent sample t-test; AO/OTA: Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association; BMI: body mass index; M/F: male/female; TBW: Tension band wiring; H/LPP: hooked part of the locked patellar plate;*

was longer for H/LPP group 72.5 ± 9.1 vs 64.3 ± 7.2, adjusted p = 0.046. All fractures in both groups achieved radiological union within 12-16 weeks. There were no cases of non-union or delayed union. All secondary outcome remained significant following Holm-Bonferroni corrections, as shown in Table 2. Complications during follow-up were described in Table 3; they showed higher trend in TBW (33.35 %) vs HLPP (8.3 %), p = 0.098. Four of the TBW cases suffered from wire breakage (Figure 4, implant irritation and superficial infections), whereas 1 of the H/LPP cases showed only transient discomfort. Neither group suffered fixation loss, migration, or deep infection.

Table 2: Functional outcome and clinical significance regarding Lysholm knee score (LKS), VAS score, radiological union and knee flexion

Outcome measures	TBW group (mean ± SD)	H/LPP group (mean ± SD)	Mean difference (95 % CI)	P -value	Adjusted p-value
LKS	79.2 ± 6.5	89.4 ± 4.8	10.2 (5.8 - 14.6)	0.002	–
VAS score (pain)	3.1 ± 1.2	1.8 ± 0.9	-1.3 (-2.2 - -0.4)	0.004	0.012[c]
Mean range of knee flexion (°)	110 ± 100	125 ± 80	15 (7.2 - 22.8)	0.005	0.010[c]
Time of union (weeks)	11.2 ± 1.8	10.3 ± 1.5	–0.9 (–2.2 - 0.4)	0.125	0.125[c]
Mean operative time (minutes)	64.3 ± 7.2	72.5 ± 9.1	8.2 (1.3 - 15.1)	> 0.050	0.046[c]
Radiographic union; n (%)	100.0 (12/12)	100.0 (12/12)	–	–	–

**Analysis was done using independent sample t-test; c Holm-Bonferroni adjusted p-value for multiple compression; negative difference favours H/LPP group: VAS: visual analogue scale; TBW: Tension band wiring; H/LPP: hooked part of the locked patellar plate;*

Table 3: Complication list encountered during follow-up period

Reported complication	TBW group (n = 12)	H/LPP group (n = 12)	Note /outcome
Wire breakage	1 (8.3 %)	0	Occurred after 1 year and was reoperated on
Symptomatic implant irritation	2 (16.7 %)	0	The implant was removed after 12 months
Implant-related discomfort	0	1 (8.3 %)	Spontaneously resolved
Superficial infection	1 (8.3 %)	0	Resolved with antibiotics
Total number of patients with complications	4 (33.3 %)	1 (8.3 %)	P = 0.089
Non-reported complication			
Loss of fixation	0	0	–
Migration			
Deep infection			

TBW: Tension band wiring; H/LPP: hooked part of the locked patellar plate;

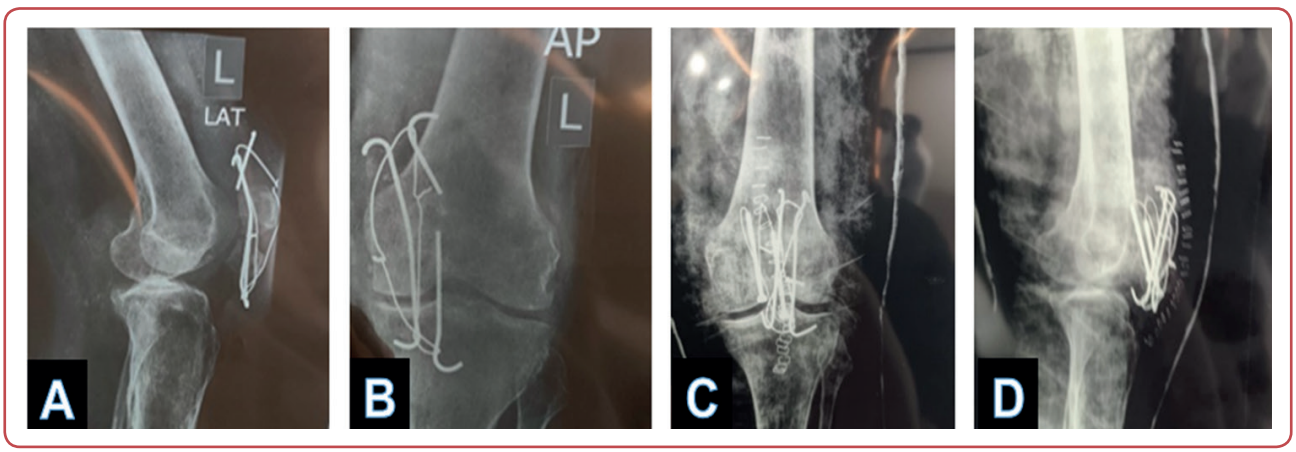

Figure 4: A 41 years old male patient with wire breakage after one year from fixation of patella fracture treated by tension band wiring (TBW) (A, B); Re-operation was done by cannulated screws with TBW (C, D)

Discussion

Patella fracture represents a challenging injury, especially when comminuted, as the patella is essential for the knee extensor mechanism function and articular congruity. Proper fixation aims to restore anatomical alignment and early mobilisation to reduce post-operative complications such as joint stiffness and non-union.[15]

This comparative study evaluated the clinical and functional outcomes of TBW and H/LPP in patellar fractures with a minimum follow-up period of 1 year. Results demonstrated superior functional scores, lower pain scores and greater knee range of motion in the hooked plate group. While union rates were comparable in both groups, complications showed a higher trend in the TBW group. The current study showed that the functional outcome, measured by the Lysholm score, was significantly higher in patients treated with the H/LPP compared with TBW ($p = 0.0016$).

Bickel et al[16] conducted a 1-year retrospective study comparing locked plating (LP) vs cerclage compression in 63 patients. Their results showed comparable functional outcome in terms of Lysholm score ($p = 0.85$) for both approaches despite the fact that LP was used for more complex cases. Moreover, it showed better safety and a less complication profile compared to cerclage compression. A larger sample size may explain the discrepancy with current results.[16]

Pain outcomes assessed by VAS in this study favoured the H/LPP, consistent with Yang et al,[17] who found lower post-operative VAS scores in patients treated with locking plates, attributing the difference to less hardware irritation and a reduced need for secondary implant removal. In contrast, TBW has been associated with symptomatic wire breakage, migration and soft-tissue irritation, which negatively affects patient comfort and often necessitates re-operation.[12, 18]

Presented analysis showed that knee flexion averaged 125° in the H/LPP group compared with 110° in the TBW group, which indicate a functional advantage of plate fixation allowing an earlier and safer mobilisation of the joint. Comparable findings were reported by Kadar et al,[19] who discussed greater knee flexion and earlier return to activity in patients treated with plate fixation, which implies that rigid fixation promotes early rehabilitation.

The radiological union was attained in all patients of both groups (100 %), which confirms that both TBW and plate fixation are dependable options for fracture healing. This agrees with Kim et al,[20] who reported union rates above 95 % for both methods.

In the current study, complications arose in 33.3 % vs 8.3 %; $p = 0.089$ in the TBW vs H/LPP group, respectively. Complication rates with TBW include: K-wire migration, loss of reduction and anterior knee pain, leading to secondary surgeries in up to 60 % of cases due to hardware-related complications.[21, 22] In contrast, plate fixation techniques, while more technically demanding, have demonstrated lower rates of hardware irritation and implant removal.[23]

Presented results signified a significant difference in operating duration. TBW had shorter operative timing compared to HPP owing to the need for careful contouring of the plate, insertion of multiple screws and verification of patellar articular congruity. Operative time was longer in the plate group of this study; in good agreement with Chang et al study.[24] The superior functional outcomes, reduced pain and lower complication rates appear to outweigh this drawback. Presented results align with these reports, reinforcing the growing consensus that plate fixation, particularly the hooked or locked variants, offers biomechanical and clinical advantages over TBW, particularly for complex patellar fractures.

This study's results demonstrate that both TBW and plate fixation achieved reliable fracture union; however, functional outcomes differed significantly. HPP fixation provided superior functional outcomes, lower pain scores, improved range of motion and fewer complications.

These findings support the adoption of plate fixation as a preferable alternative, particularly in comminuted or unstable patellar fracture patterns. The hooks capture small fragments that cannot hold screws alone, preventing secondary displacement and maintaining the integrity of the articular surface. In contrast to TBW, while effective for simple transverse fractures (AO 34-C1), it may be less stable in C2-C3 fractures and is more susceptible to complications, such as wire breakage or loss of reduction, as reflected by slightly lower functional scores in our cohort.

We have to recognise some of the drawbacks of H/LPP fixation from a surgeon's point of view; the surgery is technically challenging; it requires surgical expertise and instruments. The procedure of contouring plate and screw placement is time-consuming and thus increases operating time, with inherent prolonged anaesthesia. The issue of implant irritation is worth mentioning; there are reports of hardware prominence that led to a second surgery to resolve. Finally, the high cost and limited access may limit access, especially in low-resource settings.

Study limitation, strength and future research suggestions

A small sample size and being a single-centre study may underestimate complications. Perioperative protocol used here followed institutional practice and thus were not standardised regarding the long antibiotic prophylaxis and individualised analgesia. While this might exceed current stewardship recommendation still all cases received ideal care to minimise in-between group bias. The follow-up period was relatively short, which may not capture long-term outcomes such as arthritis or implant survival and hardware issues. Owing to the surgery complexity and since the technical variability was not addressed here, the surgeon's expertise with plates might have influenced the outcome and thus limited generalisation. We recommend that the interpretation of the results be made with caution.

To the best of our knowledge, this was the first study that evaluated these two surgical approaches in our country, which can serve as the foundation of larger studies in the future. The study has directly compared TBW H/LPP using validated measurements (Lysholm score, VAS, range of motion) aligned with those of the interventional measurements, which reinforces the study's validity. The patients enrolled were those who would most benefit from H/LPP; ie, active adults with comminuted fractures, thus it showed high clinical relevance. Finally, there was a holistic approach in evaluating outcome, radiological union, pain felt, complications reported and functional activity reached.

H/LPP is recommended over TBW for managing patellar fractures, especially in active adults who require early rehabilitation. Additional evaluation modalities through imaging, such as CT scans, may better stratify fracture complexity and optimise fixation strategies and long-term follow-up to assess long-term complications, including post-traumatic osteoarthritis. Future studies with larger cohorts and multicenter designs are needed to validate these findings.

Conclusion

Both TBW and H/LPP are effective for patella fracture fixation, but H/LPP provide superior functional outcomes, particularly in knee flexion, pain reduction and Lysholm score, likely due to more stable fixation and preservation of small fracture fragments; offers biomechanical and clinical advantages over TBW in the treatment of different types of patella fractures. H/LPP is favoured in active adults or resistant fractures exhibiting a faster functional recovery with reduced rates of implant failure or loss of the reduction despite the increased initial cost differences.

Ethics

The Ethics Committee of Mustansiriyah University issued the study approval with a number IRB 42, dated 25 September 2023. All patient gave informed consent for anonymised data publication.

Acknowledgement

None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

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