

International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2020; 6(3): 845-851
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www.orthopaper.com
Received: 10-06-2020
Accepted: 12-07-2020

Dr. Shreya Joshi
Department of Orthopaedics
P.G.I. Swasthiyog Pratishthan,
Miraj, Maharashtra, India

Dr. Sunil G Kulkarni
Department of Orthopaedics
P.G.I. Swasthiyog Pratishthan,
Miraj, Maharashtra, India

Dr. Vidhisha Kulkarni
Department of Orthopaedics
P.G.I. Swasthiyog Pratishthan,
Miraj, Maharashtra, India

Dr. Tejas Patil
Department of Orthopaedics
P.G.I. Swasthiyog Pratishthan,
Miraj, Maharashtra, India

Dr. Nikhil Lambat
Department of Orthopaedics
P.G.I. Swasthiyog Pratishthan,
Miraj, Maharashtra, India

A study of functional and clinical outcome for augmentation plating with tension band wiring for complex patella fractures

Dr. Shreya Joshi, Dr. Sunil G Kulkarni, Dr. Vidhisha Kulkarni, Dr. Tejas Patil and Dr. Nikhil Lambat

DOI: <https://doi.org/10.22271/ortho.2020.v6.i3m.2292>

Abstract

Background: Tension Band wiring is a standard age-old technique used for treating simple fracture patella. However comminuted fracture patella treated only with tension band wiring the results were not satisfying as the rigid and anatomical fragment fixation was not possible. Here we describe a newer method of using a low profile plate along with the standard tension band wiring for treating the comminuted fracture patella with the aim of getting anatomic and rigid fixation and good function. The purpose of this prospective study is to determine the effectiveness of this technique of augmentation plate with tension band wiring used in comminuted patella fracture and its effect on functional and clinical outcome.

Methods: Between Jan 2015 and May 2019, 30 patients with displaced comminuted fracture of patella were included in the study. All the patients underwent fixation of fracture of patella with low profile plate and tension band wiring. The knee function of the patients and status of the patient were determined using Lysholm knee score and KOS score.

Results: The average follow up period was 12 -15 months. At 12 months follow up bone healing was satisfying in all the patients and the average range of motion was 0-120 degree at the end of 12 months. Score Lysholm knee scale: The results were excellent in 21 patients, good in 8 patients and 1 patient with rupture of ligamentum patellae had gradual (excellent) results. One patient had complication with ligamentum patellae rupture on subsequent fall at 8th month and required resurgery and repair for the same.

Conclusions: The technique of augmentation plate is as effective and safe for treating complex comminuted fracture patella with excellent clinical outcome and results.

Keywords: Tension band wiring (TBW), complex patella fracture, augmentation plating, patella

Introduction

Patella is the largest sesamoid bone contributing to the biomechanics of knee joint. The patella bone contributes highly to the extensor mechanism as the extensor retinaculum is attached to it and plays important role in the knee extension and flexion. It increases the effectiveness of the quadriceps muscles by 30% by increasing the moment arm of the extensor mechanism [1]. Patella is an unusual fracture accounting for 1% of skeletal injuries the male to female ratio is 2:1 and common age group is 20-50 yrs.

Most of the fractures are caused by injury to the extensor mechanism (indirect) or direct blow to the patella. Fractures with intact extensor retinaculum and undisplaced fracture can be treated conservatively [2]. Fractures with retinaculum disruption and intra articular step of 2-3 mm and a gap of 4-5 mm require surgical intervention and were treated with anterior tension band wiring [2-4]. But newer techniques in the patella fracture fixation have been reported. Operative management in comminuted fracture continue to be challenge and poor outcome leading to resurgery [5-12].

The purpose of our study is to treat the comminuted complex patella fractures with augmentation plating along with anterior tension band wiring to reconstruct the patellar shape maintaining the articular congruity and improvement in the functional and clinical outcome and increased range of motion.

Corresponding Author:
Dr. Shreya Joshi
Department of Orthopaedics
P.G.I. Swasthiyog Pratishthan,
Miraj, Maharashtra, India

Materials and Methods

A total of 30 patients with closed displaced comminuted patella fracture enrolled between Jan 2015 -May 2019 were included in the study. Patients with articular fractures (complex) 34C2 and 34C3 (AO/OTA) and comminuted inferior pole fracture were considered in the study [13-15]. The fracture had an articular step off of 2mm or more and the separation of the fracture fragments were 3mm or more with retinaculum injury. This study was approved by the ethics committee of PGI SP concerning the publication of this manuscript and any images and all patients provided informed consent.

Surgical Techniques: Patient taken in supine position on a radioluscent table after giving spinal anaesthesia. Surgery performed under high tourniquet. Longitudinal Midline incision was taken and a thick flap of skin was elevated. The fracture exposed and the torn retinaculum visualised. Hematoma drained and thorough wash given, the minimal soft tissue elevated at the fracture edges and with a reduction clamp(tenaculum) fracture reduction achieved under fluoroscopy the articular surface of the patella seen and 2 parallel k wires of 1.5 mm passed holding the reduction. A low profile plate placed on the anterior surface in such a way that the screws are placed in multidirection holding the comminuted pieces. The tension band passed in the figure of 8 and construct completed with 5-6 turns. Articular congruity is checked manually and confirmed under fluoroscopy. Final image under fluoroscopy taken and the reduction checked in lateral for the articular surface and the length of the screws and in AP for the position of the plate and the tension band. Wires cut and bend and buried in the soft tissue. Thorough wash given the torn edges of the retinaculum sutured wherever possible with 2-0 vicryl. Closure done dressing given and tourniquet deflated.

Post Operative Follow-Up: Dressing done on 3,5,11 days. Continuous Passive Motion (CPM) started from POD 1 upto 40 deg and increased as tolerated by the patient. Active range of motion started from POD2. Partial weight bearing mobilisation done immediate next postoperative day. Range of motion exercises started from POD2 under the supervision of a physiotherapist to achieve flexion upto 90 degree by end of 4 weeks and full range of motion at 3 months follow up. Radiographs were obtained at weeks post op and every month for 3 months and then once in 3 months for a year. At final follow up radiographs viewed to see union implant failure or loosening of implant or loss of articular congruity. The assessment done with active range of motion, Lysholm knee score and KOS score.

Results

30 patients (men and women) included average age of 46yrs and 6 months. Mode of injury direct trauma trivial fall (12) and road traffic accidents (18). Representative images of the fracture for 2 of the patients are shown in Figures 1 and 2 respectively.

The surgery was performed as described above. Pictures taken illustrate the surgery procedure for patient 1 (Figure 3) and patient 2 (Figure 4). Patients radiographs (Figure 5 and 6) were collected to track if the surgical implants were properly placed or not. The patients were monitored throughout the course of recovery upto 12 months. Full range of motion flexion and extension achieved in all patients at the end of 12 months (Figure 7).

After an average follow up period of 12 months, bone healing was observed through final follow up. Resurgery required in 1 patient for ligamentum patellae rupture after a subsequent fall at 8 months and the ligamentum patellae was repaired using SS wire and the patient continued to have extension lag of 10 degrees. One patient had extension lag of 10 degrees with gradually improved at 6 months follow up. There were no loosening of screws or implant back out or breakage of implants. Lysholm score excellent (Figure 8) (95-100) -21 patients, Good (84-94)-8 patients, and Satisfactory (65-83)-1 patient. Statistical analysis done by One-way ANOVA.

KOS ADL score was also analysed for the patients at 1-month, 3-months and 12-months post surgery. It was observed that the average KOS was 64.3 out of 70 with a range of 55-70 (Figure 9). Statistical analysis done by One-way ANOVA.

Complications

The procedure is safe and there were no associated complications with the technique except for the one patient who was treated with 2.7 mm low profile plate along with tension band wiring who sustained a subsequent fall at the 8th month of the primary surgery and had a ligamentum patellae rupture from the apex of patella which was treated with another surgery in form of fixation of the same using S S wire. The patient had earlier restriction of motion after the second surgery but with due physiotherapy the functional outcome was eventually excellent.

Discussion

The widely accepted surgical technique for patella fracture in anterior tension band wiring [3, 4]. For transverse patella fracture it is still reckoned the best and the most effective method. However in types 34C2-C3 the more complex and comminuted fractures of patella with gap of 3mm or more lack the adequate strength to support TBW resulting in the failure of fixation prior to bone union. Additionally, since the fracture is on the rise in the older population due to trivial fall the osteopenic bone does not support the tension band wiring alone [16]. This poor bone quality and lack of rigid fixation in 34C2-C3 type fractures has an effect on the range of motion which is restricted and delayed physiotherapy and also it was observed that there was guarded post op exercises to prevent loss of reduction.

Earlier these complex comminuted fractures were treated with partial or total patellectomy but there was poor functional outcome [17, 18]. It resulted in extended immobilization and poor functional outcome as it defies the purpose of surgery to provide a good early mobile joint. In spite of many newer techniques the management of comminuted patella fracture continue to be a challenge with failure of procedure and requirement of resurgery and poor functional outcome. The principle of tension band is that the tensile forces are transformed into the compressive forces which itself was earlier considered as an indication of using TBW in comminuted patella fractures where it withstands eccentric loading and promotes fracture union. And also it is a relatively less expensive surgery and skill required are also modest.

The primary disadvantage is the repetitive motion can lead to failure of reduction and rupture of the wire if there is too much tensioning and implant back out causing pain and upwards migrations of the wire irritating the quadriceps bulk or impinging on the patellar tendon thus causing delayed recovery and poor function leading to a requirement of another procedure. TBW still serves as a widely used and

accepted method for treating fracture patella; hence we use a technique where we improve the fixation by adding a small fragment plate [5-12, 19-21]. Our technique is doing a tension band wiring with augmentation plate, we use a low profile plate system with TBW to fix the comminuted fracture which do not give a satisfactory result using only TBW. The reduction is not maintained by the TBW alone as all the fragments cannot be compressed in reduced position

We first use a small fragment plate to fix the longitudinal and oblique comminuted piece and convert the fracture configuration from complex to a 2 part fracture which is then fixed with a TBW [3, 22]. The method has its advantages and disadvantages. Firstly, it makes it easy to hold the small fragments of the bone which cannot be held in a lag screw [23, 24]. Secondly, multiple small plates can be used for severe comminution. Third, using the multidirectional screws and as the plate is sitting on the anterior (convex) surface of patella it can take care of the fracture in the coronal and oblique plane [10]. Fourth, as the contact surface is levelled and also the small plate can be bent to sit on the rim it can bring about compression and maintain articular congruity [20]. Fifth, simple technique and less skill demanding. Sixth, biomechanically it gives a stronger construct. The forces across the patella are evenly distributed and it prevents the

implant related complications which occur during knee motion (flexion and extension). The biomechanically stable construct allows early motion and avoids disruption at the fracture site or migration of the k-wires.

Comparing augmentation plates with lag screw fixation a smaller 2.0 or 2.7 mm system is used and the multidirectional screws allow holding the fracture in any plane and gives rotational stability and also maintains articular congruity. The combination of TBW with augmentation plate works wonders as it uses the principles of TBW to its advantage and eliminates the disadvantages which are taken care of by the plate. The construct allows stable fixation, allows fixation in all planes, rigid stabilization, osseous union of the comminuted fragment, early mobilisation, shorter recovery period, early weight bearing, and decrease knee stiffness, reduction in chances of non unions and complications and improved functional outcome and preventing early onset patellofemoral arthrosis [16].

In our study we have one device complication where the implant was sitting on the inferior pole and patient sustained a fall post-operative 8 months and had ligamentum patella rupture which has to be treated surgically [19]. Limitation of the study is short term follow up not known long term complications and smaller study group.



Fig 1: Patient-1 radiograph of Fracture The images illustrate the antero-posterior (AP) view, lateral view and 3-D CT scan images of the comminuted inferior pole patella fracture.



Fig 2: Patient-2 radiograph of Fracture The images illustrate the antero-posterior (AP) view, lateral view and 3-D CT scan images of the comminuted patella fracture 34C3.

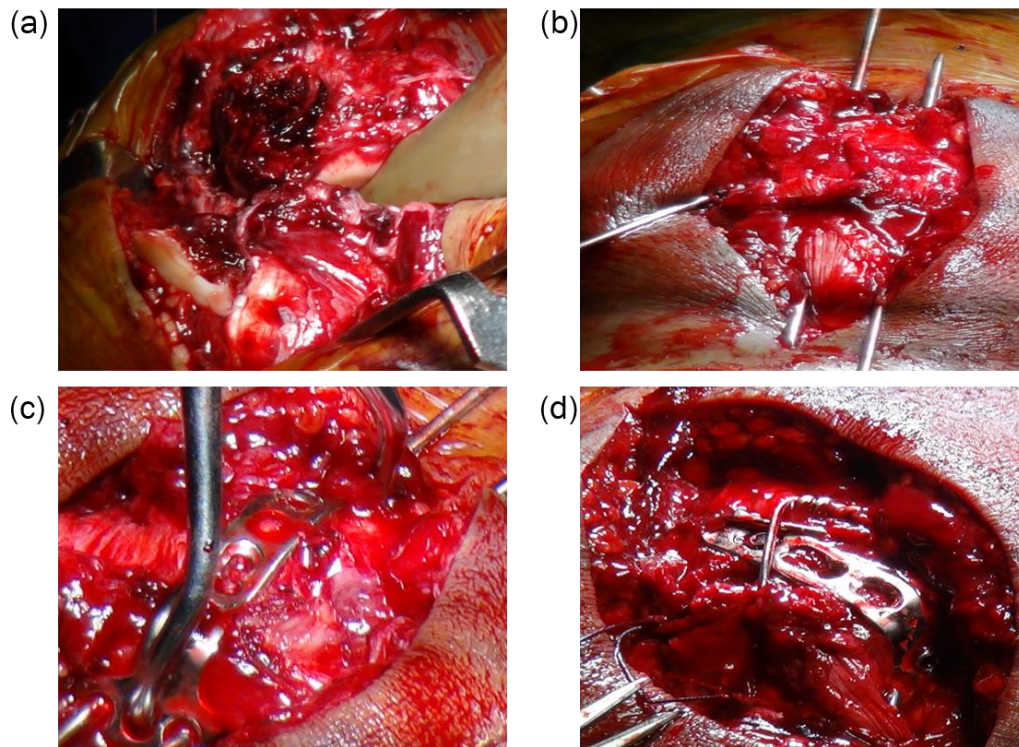


Fig 3: Surgical Procedure snapshots for patient 1 The figure illustrates snapshots taken during the surgery at different stages (a) The incision taken to expose the fracture site and fracture fragments, (b) Reduction of the fracture fragments with tenaculum, (c) Insertion of two parallel k-wires holding the fracture in a reduced position, and (d) Fracture held in reduced position with low-profile plate and TBW around the k-wires.

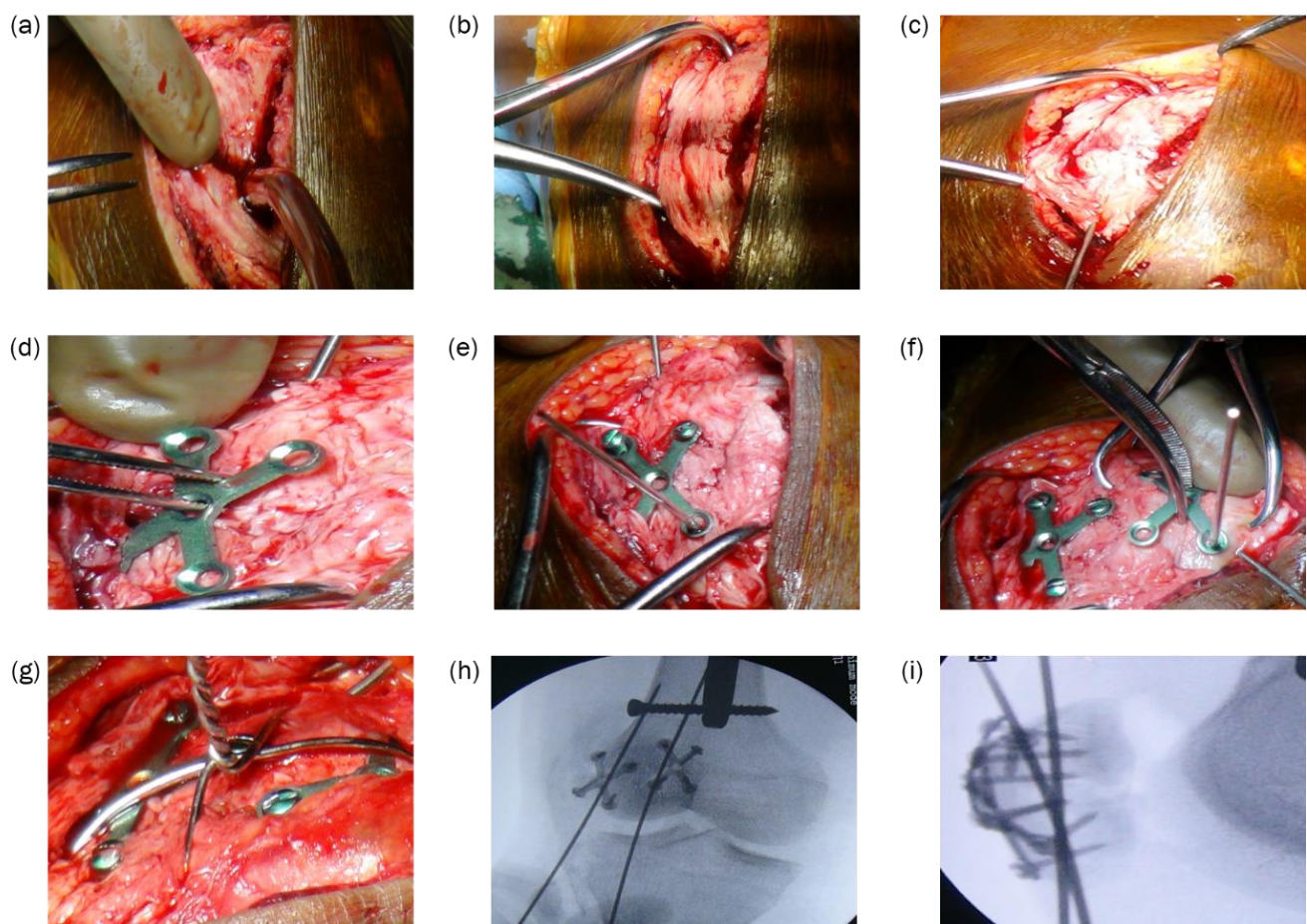


Fig 4: Surgical Procedure snapshots for patient 2. The figure illustrates snapshots taken during the surgery at different stages (a) The incision taken to expose the fracture site and fracture fragments, (b) Reduction of the fracture fragments with tenaculum, (c) Insertion of two parallel k-wires holding the fracture in a reduced position from inferior to superior pole, (d,f) placement of 2mm low profile on anterior patellar surface, (e) securing the plate with screws, and (g) fracture held in reduced position with low-profile plate and TBW around the k-wires. C-arm images showing (h) AP view and (i) lateral view of the implants and articular congruity.

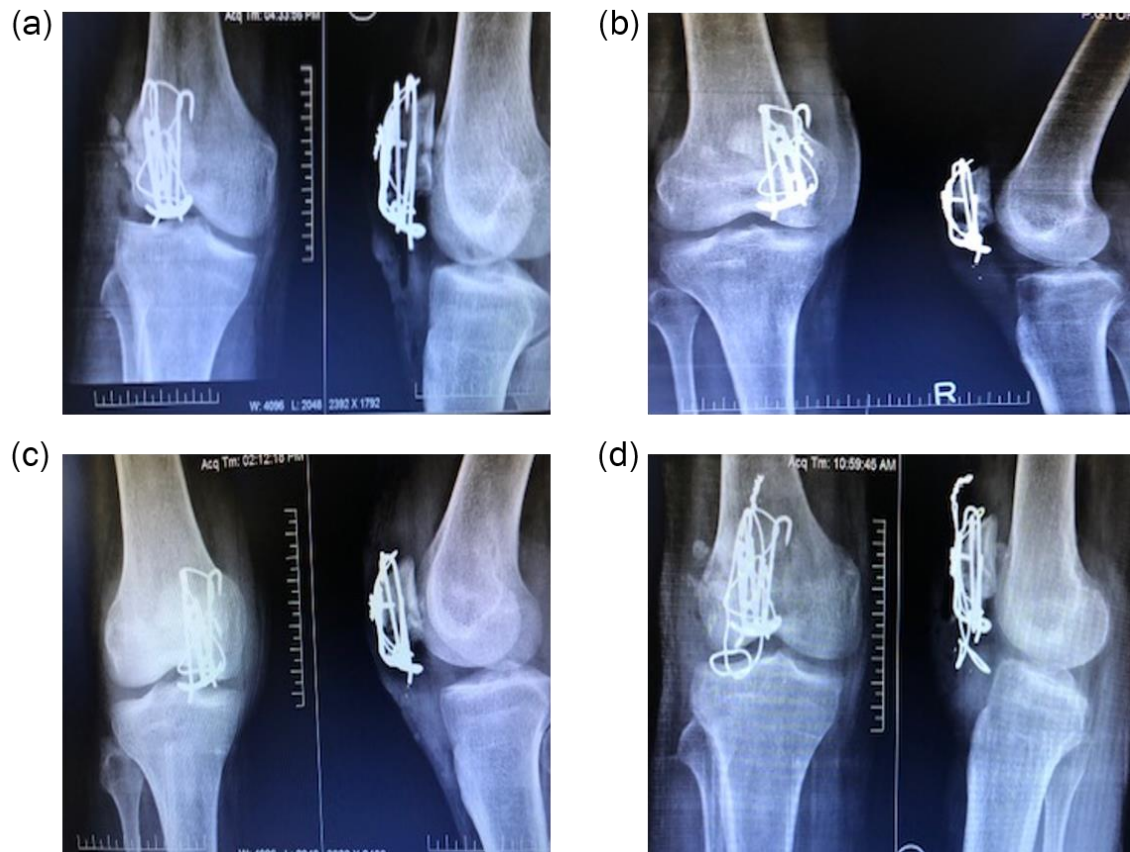


Fig 5: Patient-1 radiograph after surgery The AP and lateral X-ray images of post-surgery at 1-month (a), 3-months (b), and 6-months (c) follow-up. (d) 8-month follow-up showing fracture union and ruptured ligamentum patellae sutured with SS-wire.

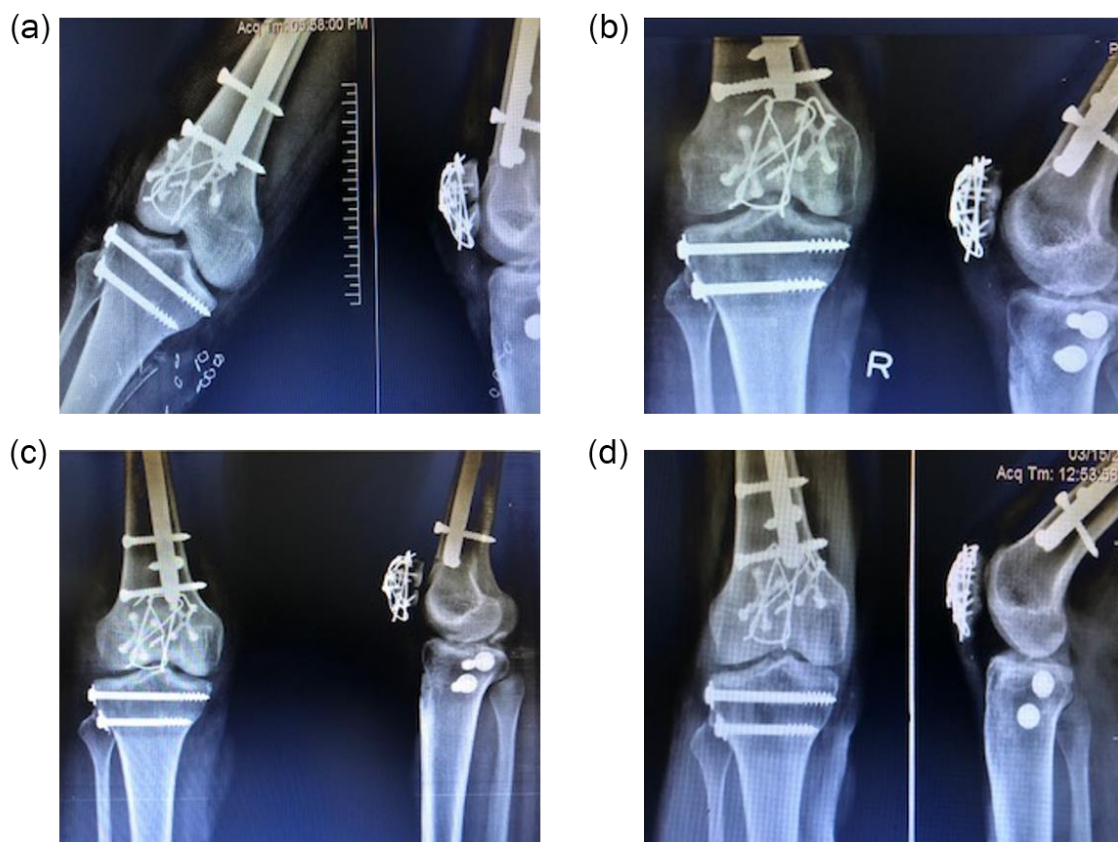


Fig 6: Patient-2 radiograph after surgery The AP and lateral X-ray images of post-surgery at 1-month (a), 3-months (b), 6-months (c), and 1-year (d) follow-up showing fracture union.



Fig 7: Clinical representation of the Range of Motion Complete flexion and extension achieved in both, patient 1(a-d) and patient 2 (e-f).

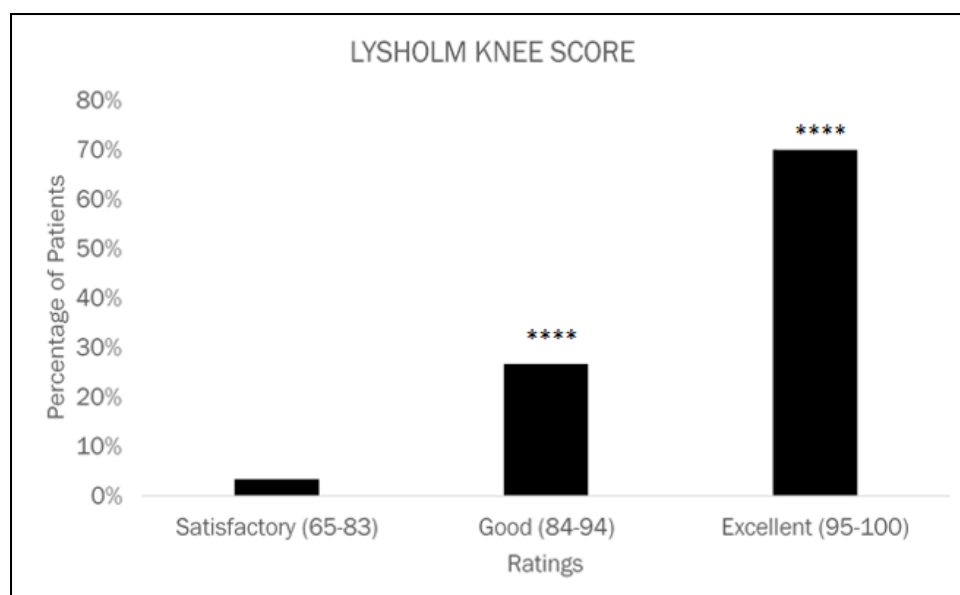


Fig 8: Lysholm Knee Score for all patients. There is a significant increase in the number of patients in the good (p-value <0.0001) and excellent range (p-value <0.0001) compared to the satisfactory range.

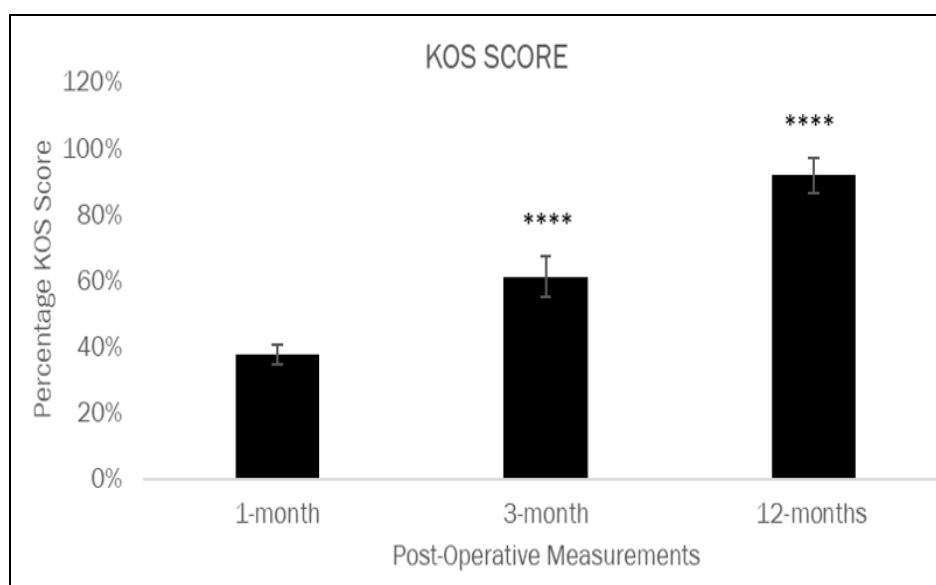


Fig 9: The steady increase in the KOS scores observed at 1-month, 3-month vs 1-year post-surgery. There is a significant increase at 3-month (p-value <0.0001) and 12-months (p-value <0.0001) compared to the 1-month timepoint post-surgery.

Conclusion

The tension band wiring with augmentation plate is biomechanically a superior construct and both the implants compliment each other and add to rigid fixation with good clinical and functional outcome of a comminuted complex patella fracture.

Clinical Relevance

The TBW with augmentation plating is a relatively easy safe inexpensive less technically demanding procedure with immediate post op mobilisation.

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