

# A Comparison of Braided Polyester Suture Fixation vs. Metal Tension Band Wiring in Patellar Fractures

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## ABSTRACT

**Objective:** To look at the outcomes of surgery comparison between two groups and to assess the risks and complications associated with each procedure.

**Methods:** This study performed a retrospective process of all patella fixations from 2004 – 2011. Case notes were reviewed and patients were assessed using objective and functional scores and complication rates compared.

33 patients were identified from the theatre registry. Nine patients underwent braided polyester suture fixation compared with 20 metal Tension Band Wire (TBW) fixation. Four were excluded – 3 were periosteal sleeve fractures, 1 was a revision of a metal tension band wire fixation. The mean age at the time of injury was 53.2 years of age (range 20 – 87, SD – 21), with a male to female ratio of 18:11. Mean follow-up was 29 months (range 1 – 84, SD – 29.6). 8 were lost to follow-up. 6 were deceased.

**Results:** Mean range of movement was comparable in both groups – mean extension was 0.7 degree in the braided polyester suture fixation group vs. 2.7 degrees in the metal TBW group ( $p>0.05$ ). Mean flexion was 98.1 degrees in the braided polyester suture fixation group vs. 98.8 degrees in the metal TBW ( $p>0.05$ ). Mean Knee Injury and Osteoarthritis Outcome Scores (KOOS) was 80.6 in the braided polyester suture fixation group vs. 72.6 in the metal TBW group ( $p>0.05$ ).

2/9 (22%) of braided polyester suture fixations failed early – 1 primary failure, 1 secondary to trauma.

There were no early failures in the metal tension band wiring group but 45% were removed at a later date due to sequelae of prominent metalwork ( $p=0.03$ ).

**Conclusion:** Results of braided polyester suture fixation showed that outcomes are comparable. The main advantage is that there is no soft tissue irritation in the braided polyester suture fixation group.

## INTRODUCTION

Patella fractures are common injuries and account for 1% of all fractures[1]. These can occur from direct or indirect trauma, resulting in comminuted or transverse fracture patterns [2]. Due to the intra-articular nature of the patella and the biomechanical advantage that it offers, it is generally accepted that the aims of treatment are to restore the articular congruity and extensor mechanism, whilst preserving as much of the patella as possible[3]. As a result, open reduction and internal fixation using a tension band wire principle is an established technique for definitive management of

these fractures. However, due to the subcutaneous location of the patella, the reported rates for hardware removal have been as high as 60% [4].

As a result, alternative techniques and materials have been studied and undergone biomechanical testing to assess its suitability for patella fracture fixation. Particular interest has been shown in the use of braided polyester suture material as a tension band. Hughes et al. performed biomechanical testing on a patella model comparing braided polyester suture with stainless steel wire and showed no difference [5]. Biomechanical studies in cadaveric patellae and showed no difference in performance with conventional stainless steel tension band wiring [6,7] .

There have been few clinical studies regarding this technique, each with considerable variation in technique. Yotsumoto et al. describe using a polyblend suture as a tension band with ring pins instead of parallel Kirschner wires as a method of fixation [8] .

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Gosal et al. describe using braided polyester suture as a cerclage as well as tension band technique [9].

All of these methods still incorporate the use of metal wires across the fracture site and is augmented with a suture tension band. This study describes a completely metal-free braided polyester suture fixation and compares the results with metal tension band wiring.

Our study aims to compare the outcomes of braided polyester suture fixation with traditional metal tension band wire fixation and assess the complication rates.

## METHODS

This study was undertaken in a trauma and orthopaedic department in a local district general hospital. We performed a retrospective case note review of all patella fracture fixations between 2004 and 2011. The range of movement in the knee was noted at the time of discharge from fracture clinic. Outcome scores were collated via telephonic interview using Knee Injury and Osteoarthritis Outcome Scores (KOOS). Complication rates were also assessed.

All patients in the study sustained fractures amenable to operative fixation using a tension band wire principle. Inclusion criteria included a disruption of the extensor mechanism or if there was significant displacement of the articular cartilage (>2mm) or fracture separation (>1mm). All patients had closed fractures.

We identified 33 patients from theatre logbooks. Four cases were excluded – three cases were diagnosed as periosteal sleeve fractures and not amenable to tension band wire fixation, one was a revision of an infected metal tension band wire fixation from another centre. Of the remaining 29 patients, 18 (62%) were male and 11 (38%) were female. The mean age at the time of injury was 53.2 years of age (range 20 – 87, SD – 21). The mean follow up was 29 months (range 1 – 84, SD – 30). 14 (48%) patients were lost to follow up – 6 (21%) were deceased at the time of the study (mean of 49 months post-op), 8 (28%) were unable to be contacted.

9 (31%) underwent braided polyester suture fixation compared with 20 (69%) patients who underwent metal tension band wire fixation.

### Statistical Analysis

GraphPad Prism v6.0b (GraphPad Software Inc., La Jolla, Ca) was used for statistical analysis. Demographic

data between the braided polyester suture fixation and metal tension band wire group were tested using a Mann-Whitney test. Comparison of complication rates were analysed using Fisher's exact test. Statistical significance was taken at the 0.05 level.

### Operative Technique

All operations were approached using a common technique. A tourniquet is applied and inflated to 300mmHg. The patella is exposed through a longitudinal midline incision, with medial and lateral skin flaps raised to expose the retinaculum. This allows assessment of the extent of the retinacular tears as well providing exposure to assess the adequacy of reduction of the articular surface. The fracture is exposed and fracture haematoma and haemarthrosis is evacuated before reduction of the fracture using pointed bone reduction forceps.

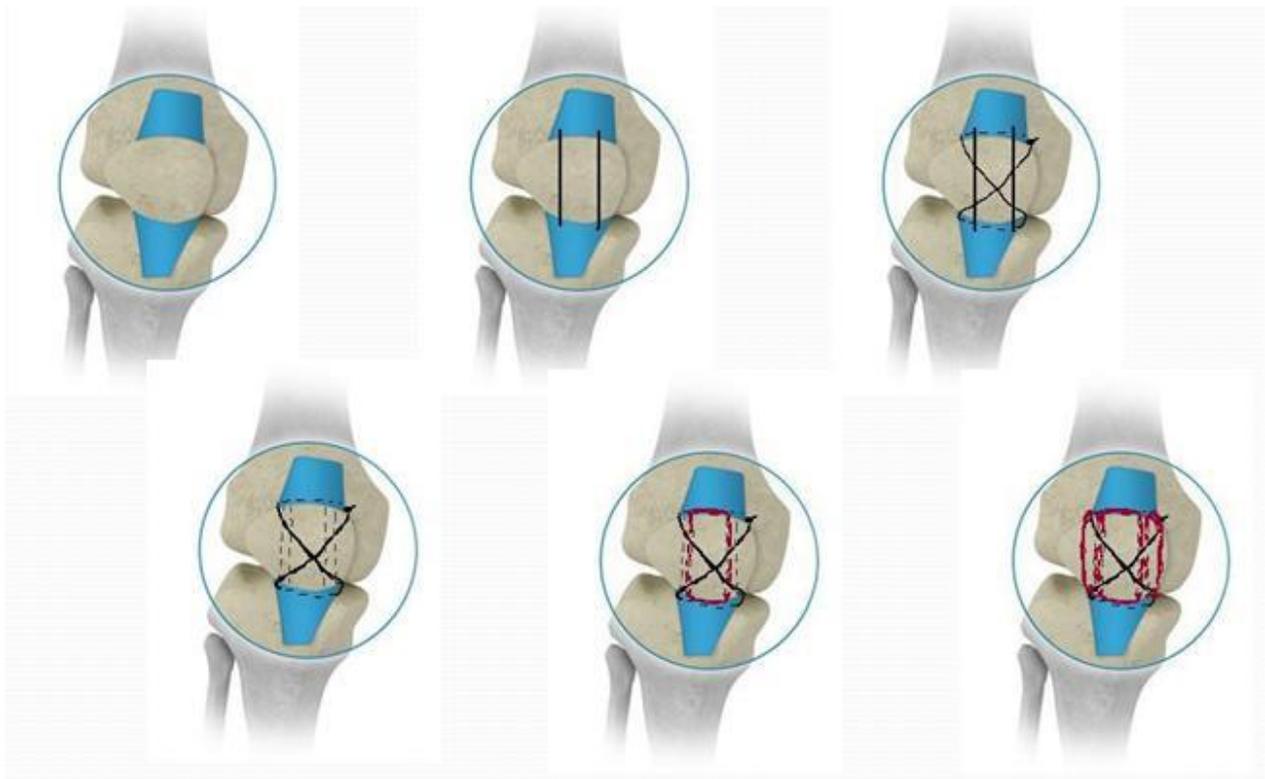
### Braided Polyester Suture Fixation

Two parallel 1.6mm Kirschner wires are passed longitudinally to temporarily transfix the reduced fracture fragments. A number 5 FiberWire® suture (Arthrex Inc, Naples, Florida, USA) is passed in a figure-of-eight configuration over the anterior patella, passing deep to the quadriceps and patella tendon and secured. At this stage, the Kirschner wires are removed and the stability is assessed. If adequate, three number 5 Fiber Wire® sutures are sutured in a two tunnel box configuration, passing through the Kirschner wire channels and secured to offer additional stability and to fix the figure-of-8 suture in situ. Each knot is secured with at least five throws with locking and ensuring that the knots are sufficiently buried to avoid soft tissue irritation. The retinaculum and paratenon is repaired (Figure 1).

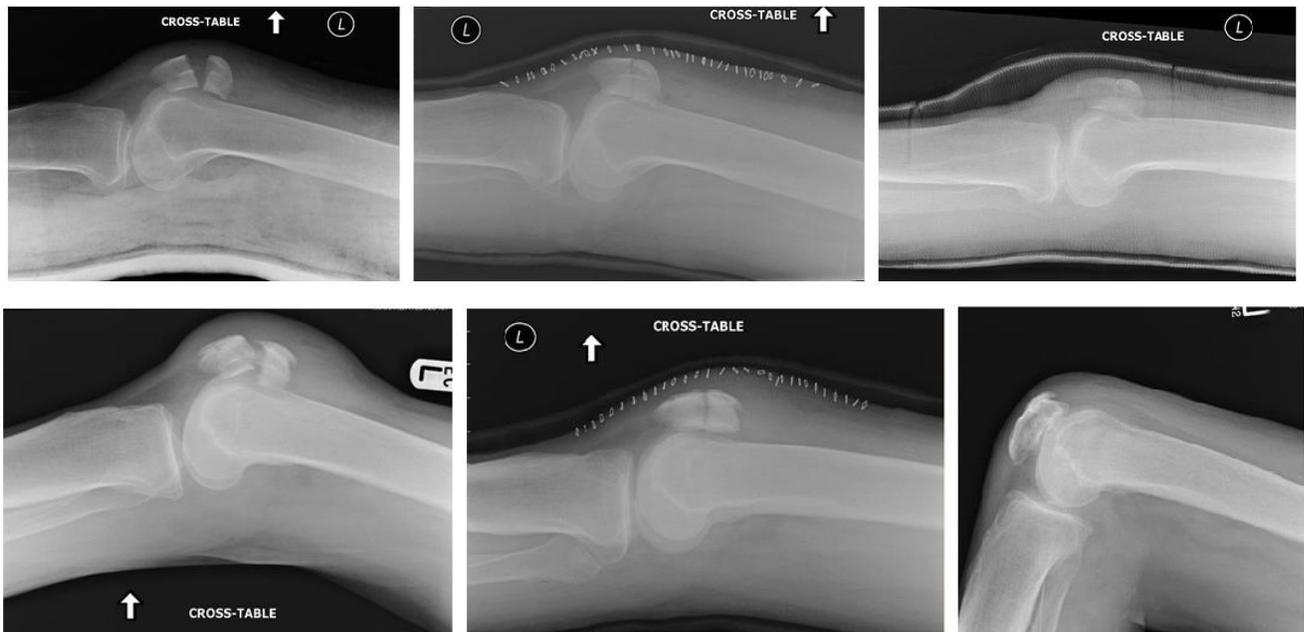
### Metal Tension Band Wiring

The operative fixation was dependent on the operating surgeon's discretion particularly with regard to the use of supplementary cerclage wires. All were fixed using an anterior tension band technique using two longitudinal 1.6mm Kirschner wires and 18 gauge stainless steel wire looped over the anterior patella.

Post-operatively, the knee is immobilised in extension in either a cricket-pad splint or plaster of Paris for 2 weeks with no restriction to weight bearing. After this period, they are given range of movement exercises under the care of the physiotherapists for a further 4 weeks.



**Figure 1:** Operative technique for braided polyester suture fixation



**Figure 2:** Serial radiographs of two patients treated with braided polyester suture fixation

## RESULTS

This cohort of patients underwent surgery at a mean of 2.1 days (range 0 – 7, SD – 2.0) after admission. Table 1

compares the demographics and shows that there is no statistical difference between the two groups.

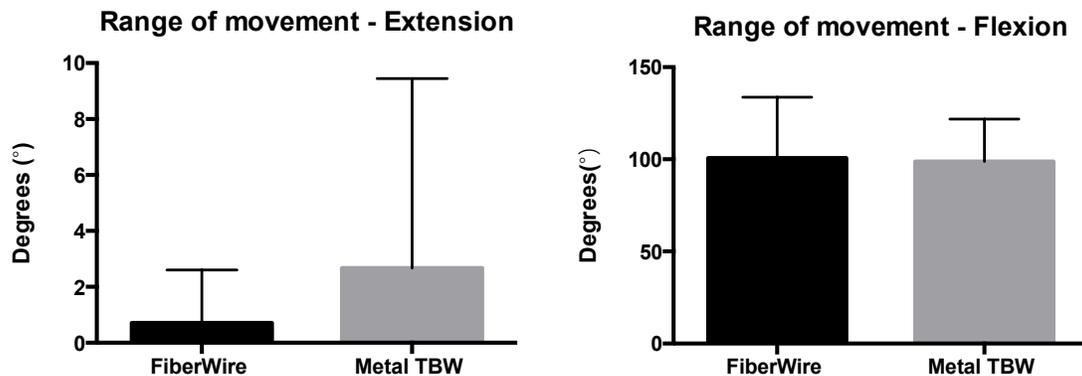
**Range of Movement**

The mean extension in the braided polyester suture fixation group was 0.7° (range 0° – 5°, SD – 1.9) compared with 2.7° (range 0° – 25°, SD – 6.8) in the metal tension band wiring group (p>0.05). The mean

flexion in the braided polyester suture fixation group was 98.1° (range 40° – 130°, SD – 31.4) compared with 98.8° (range 45° – 125°, SD – 23.1) in the metal tension band wiring group (p>0.05).

**Table 1:** Demographic breakdown of groups by type of surgical fixation

	Braided polyester suture Fixation	Metal Tension Band Wire	Significance (p value)
Mean age	57.4 (28-87,20)	51.3 (20-83, 22)	NS
Sex (M:F)	6:3	12:8	
Side (R:L)	3:6	12:8	
Mean time to surgery (days)	2.3 (0-7, 2.3)	2.0 (0-7, 1.9)	NS
Mean length of stay (days)	5.0 (1-16, 6.0)	5.6 (1-33, 7.2)	NS
Fracture Pattern			
Transverse	3 (33%)	7 (35%)	
Comminuted	6 (66%)	13 (65%)	



**Figure 3:** Mean post-operative range of movement

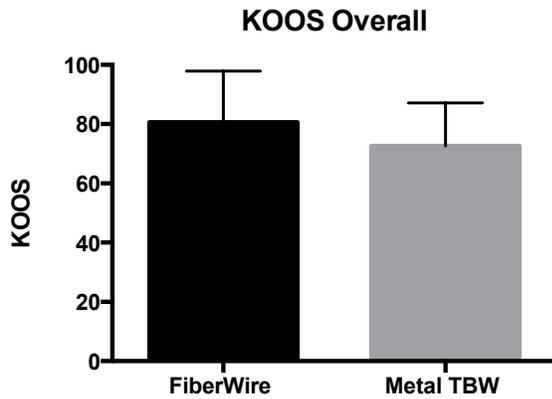
**Knee Injury and Osteoarthritis Outcome Scores (KOOS)**

There was a significant loss to follow-up for assessment of these scores. 16 out of 30 completed the KOOS questionnaire. 7 out of 9 (78%) in the Fiber Wire group completed post-operative scores compared with 8 out of 20 (40%) in the metal tension band wiring group.

Table 2 shows the breakdown of the KOOS outcome scores by each category. On statistical testing, there was no difference in the values between the 2 groups. Overall, there is no significant difference between the 2 groups although there is a trend for better scores in the Fiber Wire group.

**Table 2:** KOOS outcomes scores

Operative Treatment	Symptoms	Pain	ADL	Sport	QOL	Overall
Braided Polyester Suture Fixation (n = 7)	84	84	82	72	65	81
Metal Tension Band Wire (n = 9)	72	75	77	43	59	73



**Figure 4:** Post-operative KOOS outcome scores between the 2 groups

**Complications**

**Braided Polyester Suture Fixation**

Two of the nine (22%) braided polyester suture fixations failed at a mean of 6 weeks post-op. The first patient was a 41 year old female, who sustained a transverse fracture of the patella. She had an uneventful post-operative recovery until she had another fall 8 weeks after the initial surgery. This was subsequently revised to a metal tension band wire fixation. The fracture clinically and radiologically united after revision, but the patient had hardware problems post-operatively. This was removed 13 months after the revision procedure and had no further problems.

The second case was a 28 year old male, who sustained a comminuted fracture of the patella after a direct blow. This patient suffered a primary failure of fixation at 4 weeks. The patient had been mobilising

full weightbearing without crutches at this stage and had been walking up a hill. This was subsequently revised to a metal tension band wire, which went onto union.

**Metal Tension Band Wiring**

The total complication rate in the metal tension band wire group was 55% (Table 3), the majority of which were attributable to hardware problems. Seven patients noted prominent metalwork – one of the patient’s metalwork broke at 15 months after surgery, after the fracture had fully united and was causing soft tissue irritation. Two patients had wound problems at a mean of 6 weeks post-op. Both were treated with oral antibiotics and settled without further treatment. The metalwork was subsequently removed at a later date once the fracture had united. Two had areas of skin breakdown – one was in an immunocompromised patient undergoing chemotherapy for prostate carcinoma occurring at 5 months, and the other was a late presentation after the prominent metalwork had eroded through the skin 81 months after fixation. Both patients had the metalwork removed without any further problems.

All patients were offered further surgery to remove the metalwork. Nine patients underwent removal of metalwork. Of the two remaining patients, one patient is awaiting metalwork removal and one patient declined further surgery.

**Table 3:** Complications associated with metal tension band wiring

	Number	Percentage (%)	Mean Time to Revision (months)	Number Revised (%)
Prominent metalwork	7/20	35	16	5/7 (25%)
Infection	2/20	15	11	2/2 (10%)
Skin breakdown	2/20	10	43	2/2 (10%)
Total	11/20	55	20	9/20 (45%)

**Table 4:** Comparison of complications between braided polyester suture fixation and metal tension band wire groups

Complication	Braided Polyester Suture Fixation (%)	Metal Tension Band Wiring (%)	Significance (p-value)
Failure of fixation	2/9 (22%)	0/20 (0%)	Ns
Hardware irritation	0/9 (0%)	9/20 (45%)	0.03
Infection	0/9 (0%)	2/20 (10%)	Ns

Comparing the complications, it becomes apparent that it falls into two main groups – failure of fixation and hardware irritation. Table 4 compares the complication rates in the two groups and shows that hardware irritation reaches statistical significance in the metal tension band wiring group.

## DISCUSSION

Although methods of metal tension band wiring have proven to be successful at restoring bony anatomy, the subcutaneous location of the patella has led to a substantial rate of hardware problems. Our study has indicated a revision rate of 45% for hardware problems, which is in keeping with the current literature [4].

These complications have prompted the introduction of alternative methods of fixation to minimise these problems and include the use of braided polyester sutures.

Weber et al. originally performed biomechanical testing on different tension band wire configurations and concluded that Magnusson wiring and modified anterior tension band wire configurations produced the least fracture gapping [10]. It was also recommended that repair of the retinaculum also added to the stability of the fracture fixation. Patel et al. has gone on to show that biomechanically, braided polyester suture fixation is comparable to stainless steel wire fixation in cadaveric knee specimens in terms of pull out strength [7].

This study suggests that braided polyester suture fixation of patella fractures is a viable alternative to metal tension band wiring in the clinical setting. Results show that there is no significant difference in terms of post-operative objective and subjective outcomes between the two groups. However, it is noted that although not statistically significant, there was a trend towards primary failure in the braided polyester suture fixation group. This involved two out of the nine cases. Theories as to the possible causes include failure of the suture material or the failure of the surgical technique.

With regard to the surgical technique, Patel et al. have already documented concerns regarding adequate fracture reduction and securing the suture knot with enough tension to prevent fracture gapping. He advocated using the sliding knot technique to ensure adequate tightening of the sutures to the point of a mild separation on the articular side of the fracture before locking [7]. It is the opinion of the lead author

that the technique with braided polyester suture is more exacting due to the increased flexibility of the material in comparison to stainless steel wire.

Of the two failures, it was felt that one was due to a second traumatic episode, which led to the failure of fixation rather than a failure of the surgical technique. The second case was performed in a comminuted fracture and failed at 4 weeks. This suggests a primary failure of the technique. Unfortunately, it was not noted at the time of revision but it is the opinion of the lead author that it was due to a technical failure rather than that of the suture material.

It is noted that 6 out of the 9 braided polyester suture fixations were performed in comminuted patella fractures without adverse incident. Although tension band principle is not ideally suited to these fractures, in reality, there is very little alternative for these difficult fractures and is a widely accepted method of fixation with or without cerclage wires [4]. This is probably due to subcutaneous location of patella resulting in a lack of viable alternatives. In these cases, it may be prudent to exercise more caution and opt for a slower rehabilitation programme – immobilisation in plaster for 3-4 weeks before initiating range of movement exercises so that the fixation is less reliant on the fixation method.

Other complications documented in the literature include prominent suture knots that subsequently required removal [11]. Although the suture knots are noted to be bulky due to the number of throws required to secure the knot, this was not noted to be a problem in this study. It remains imperative that the knot is adequately buried to minimise the risk of soft tissue irritation.

Even in this small cohort of patients, the findings of the study support the hypothesis that there is a significant difference in soft tissue irritation between the two groups. Indeed, of the two failed braided polyester suture fixations that were subsequently revised to a metal tension band wire fixation, one of these went on to have the metalwork removed due to soft tissue irritation.

In summary, braided polyester suture fixation of patella fractures incorporates a completely metal-free technique that has not been previously reported in the literature. All previous braided polyester suture techniques have required the use of stainless steel wires or similar alternative for stabilisation across the fracture site, and are therefore, still at risk of soft tissue

irritation. We found this method to be biomechanically stable with comparable functional outcomes and survival. There is a learning curve to this procedure as highlighted by the complications noted in this group. None of these cases have required further surgery for soft tissue irritation.

However, more work needs to be done to consolidate the appropriate indications and post-operative management of this technique. This is to ensure that braided polyester suture fixation is biomechanically robust enough in a clinical setting and confirm that failure rates are not higher.

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