A new and effective tension-band braided polyester suture technique for transverse patellar fracture fixation

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Summary

Objectives: Concerning the tension-band principle of internal fixation, this study aims to establish whether any difference in interfragmentary gap exists after bone-reducing forceps are released, when a recommended suture-knot technique and a new technique are tested in vitro on a purpose built machine that features a model of a transverse fracture of the patella. In addition, a standard tension-band wiring technique has also been tested as one form of control.

Background: Satisfactory compression at a fracture site reduces the risk of failure of fixation, loss of reduction (interfragmentary gap > 2 mm) and subsequent risks of malunion, delayed union, and ultimately non-union from excessive movement. Stainless-steel wire can provide a stable rigid construct but is associated with complications. Tension-band fixation employing a braided polyester non-absorbable suture provides a less rigid construct. However, satisfactory clinical results and fewer complications are reported. The method by which a suture is tied has an effect on initial compression provided the fracture is reduced. However, it also has an effect on the degree of fracture gap once it is subject to biomechanical distraction.

Methods: By measuring the output of a strain gauge Wheatstone bridge of a purpose built rig that had been calibrated against fracture gap and compression force, the various tension-band fixation techniques as discussed above were evaluated.

This work represents part of a dissertation submitted by Seán C.A. Hughes for the qualification of MSc in Orthopaedic Engineering.

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Introduction

This research focuses on the reduction of a displaced patella fracture that would normally be treated by surgical open reduction and internal fixation. In essence, its scope was to produce a useful and reliable model on which to perform a limited biomechanical evaluation study of the fracture gap. Interfragmentary gap is a sequela of initial compression force applied, if any is achieved during fracture reduction. It is also a sequela of the subsequent stability of a construct, as imparted by different surgical techniques on the reduction of a fracture.

Background

The incidence of fractures of the patella accounts for almost 1% of all skeletal fractures and one-third of patellar fractures require surgery.\(^4,32\) Patellar fractures result from either direct or indirect trauma. Indirect mechanisms can result from a forceful contraction of the quadriceps with the knee flexed. These fractures are usually transverse and may be associated with tears of the collateral retinacular expansions, haemarthrosis, and localised tenderness. Most case series reported in the literature are of transverse fractures. Transverse fractures usually involve the central third of the patella but can involve the proximal or distal poles.

The important and significant effects of fracture of the patella are the loss of continuity of the extensor mechanism of the knee and the potential incongruity of the patello-femoral articulation.\(^18\) Thus, the surgical aims are to achieve restoration of articular congruity and repair of the extensor mechanism with an internal fixation construct that is rigid enough to allow early range of movement motion and rehabilitation of the patello-femoral and knee joints. Moreover, patellar fractures associated with retinacular tears, open fractures, and fractures with more than 2–3 mm of displacement or patello-femoral joint incongruity have the most favourable clinical results when operatively treated. Abnormal joint surfaces following fracture of the patella are a cause of chronic anterior knee pain, which is notoriously difficult to treat.\(^27\)

Classically, patellar fractures have been repaired with a tension-band wire technique, using stainless-steel wire and two parallel k-wires (Fig. 1a). Further modifications include a figure-of-eight configuration, attributed to Schauwecker.\(^28,32\) Wire provides a strong and stiff construct to reduce the risk of fixation failure and gap formation at the reduced fracture site.

Results: The tension-band suture technique examined in this work (the modified Wagoner's Hitch) has been evaluated. It has quantitatively shown less fracture gap than other recognised tension-band suture and wire techniques. The results exhibit statistical significance (\(p < 0.001\)).

Conclusions: This evaluation study has produced quantitative and comparable data of fracture gap as observed with the model of a transverse patella fracture, for both new and established surgical techniques. The contribution this study has made to the knowledge of the subject is that a testing device similar to the one in this study may be useful in the future for conducting preliminary studies of new or established tension-band techniques. The proposed tension-band suture method tested in this dissertation provided statistically significant quantitative data, which may after further work, support its use as an alternative method in the clinical setting.

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Figure 1  Types of patellar fixation: (A) modified tension band, (B) Lotke LAB wiring, and (C) Magnusson wiring [from Ref. [3]].
Various problems have been associated with the use of stainless-steel wire in this configuration. Patients complain of painful areas where the wire is prominent under the skin. The wire can fail over a period and become excessively prominent. Higher incidences of infection have also been reported in some series. Revision surgery to remove the wires is considered an additional risk for the patient. Consequently, there have been several papers that advocate the use of a strong suture material such as a braided polyester non-absorbable suture, utilising various tension-band suture techniques. There is a perception, however, that such suture material is weaker than steel and therefore provides a less stiff fixation construct. The advantages of using a suture over a wire, as shown in the literature, are that revision surgery is less frequent and patients tolerate a surgical material that does not irritate the soft tissues as much as wire appears to clinically. Other advantages suggested in the literature are that there is a shorter operating time and shorter tourniquet time, with easier handling of the suture materials for the surgeon.

The patella is subjected to tension on its anterior surface (via the quadriceps force) and compression at the patellofemoral joint articulation on the posterior surface of the patella; these forces vary with knee flexion angle. The bending of the patella (when considered as a beam), with tension on the anterior surface, is a major loading mechanism that must be taken into account when considering fixation of patellar fractures.

If a tension-band were applied solely to the anterior surface without central parallel Kirschner wires (Magnusson method, Fig. 1b), or without wire placed within the central plane of the patella (Lotke and Ecker, Fig. 1c), gapping during loading from flexion to extension of the knee would occur on the posterior articular surface.

It should be noted that as wire is bent around corners (around the k-wires or the bone itself), frictional forces and permanent deformation will reduce the amount of tensile force (and thus interfragmentary compression) the wire is able to transmit. Cancellous screw application has also been studied as this provides a mechanical advantage applying greater compression across the fracture in comparison to wiring. Unfortunately, as the screws rely on cancellous bone within the body of the patella, the purchase it achieves is less satisfactory considering that wire transfers its load to cortical bone. Failure of fixation, producing a gap greater than 3 mm, has been found in the cancellous screw constructs when compared to wiring under dynamic testing. Screw fixation was not tested in this study.

**Tension-band wiring**

Tension-band wiring is a form of hemicerclage wiring which can be used in conjunction with Kirschner wires. It is used to repair fractures or osteotomies of traction apophyses (patella, olecranon, greater trochanter of the femur, greater tubercle of the humerus, tibial tuberosity, acromion process of the scapular, distal fibular fractures, etc.). The use in fractures that are under dynamic tensile distractive forces, such as patellar fractures, is the most common. The tension-band principle converts distractive forces into compressive forces during muscular contraction and weight bearing.

Pauwels (1935) defined and applied the tension-band principle in fixation of fractures and non-unions. It was applied to internal fixation of eccentrically loaded bone. The engineering concept preceded this date.

Stainless-steel wiring techniques are used most frequently for transverse fractures. They also can be used in multifragmentary fractures if the fragments are large enough to lag together with screws, thereby converting the situation to one of a transverse fracture. Many different wiring techniques have been described, including cerclage wiring, alone or in combination; tension-band wiring, alone or modified with longitudinal Kirschner wires or screws; Magnusson wiring, and the Lotke and Ecker technique termed longitudinal anterior band with or without cerclage (LAB/C).

Weber et al. compared experimentally the rigidity of internal fixation constructs. They tested circumferential wiring, tension-band wiring, Magnusson wiring, and modified tension-band wiring using two anteriorly placed wires combined with two transfixing parallel Kirschner wires. They found that the most secure fixation was obtained with modified tension-band wiring. If early motion was to be initiated they recommended anchoring the fixation by wiring directly into bone rather than threading the wire through the soft tissue around the patella.

Benjamin et al. evaluated modified tension-band wiring, Lotke and Ecker wiring, Magnusson wiring, and screw fixation alone in transverse fractures and found the modified tension-band technique to provide the best fixation. They recommended its use in osteoporotic and multifragmentary fractures. Two screws alone were found to provide adequate fixation in fractures with good bone stock.

In cadaveric studies, Curtis determined that the Pyrford technique, using a cerclage wire and a second tension-band wire through tendon, provided improved fixation, especially in multifragmentary fractures.
Carpenter et al. studied transverse fractures fixed with screws alone, modified tension-band with Kirschner wires, and tension-band wire placed through cannulated screws. They found that specimens fixed with the tension-band through cannulated screws failed at the highest load.

Burvant et al. used a simulated leg-extension model to evaluate transverse fractures fixed by a modified tension-band, Pyrford technique, tension-band with screws, Pyrford technique with screws, and screws alone. Adequate fixation was obtained with all techniques. However, displacement of fragments was slightly greater with screws alone and with the Pyrford technique alone.

The literature shows that results of tension-band wiring techniques are favourable. Lotke and Ecker reported 81% good or excellent results in 16 patients treated with their technique. Similar results have been reported using modified tension-band techniques.

Although the use of stainless-steel wire for tension-band fixation is commonplace, more recently, braided polyester sutures have been utilised with success. Moreover, certain complications related to wire have been quoted as being as frequent as 47%. In other papers, 15–20% of patients treated with wire have been reported to require later removal. Gosal et al. report a reoperation rate of 38% for stainless-steel wire fixation.

Many studies do claim that wire, particularly when it fails, is an irritant to the patient, and often requires further surgery thus exposing the patient to the theoretical risk of a further general anaesthetic. There is also an argument that knot irritation from a suture can always be remedied by removal under a local anaesthetic, whereas the removal of a wire requires surgery that is more extensive. Moreover, it is possible to bury a suture-knot within the soft tissues, whereas, the twists in steel wire are notoriously difficult to bury in soft tissue, and often require tapping in via a punch.

### Tension-band suture method

The use of a tension-band suture instead of tension-band wire for fractures of the patella and olecranon remains controversial in the orthopaedic literature. A braided polyester suture was found to have minimal tissue reactivity when used clinically. Braided polyester sutures are mechanically superior to other non-absorbable and resorbable sutures in vitro, with a high stiffness and high ultimate tensile strength.

Chatakondu et al. argued that a braided, polyester, non-absorbable suture maintains its tensile strength in vivo and that it has several advantages over the use of wire. In that the suture material was easier to handle, the use of the needle allowed more accurate placement through the soft tissues in comparison to the need for guides when using steel wire. Adjustment was easier if there was misplacement of a suture in comparison to misplacement of a wire. In addition, they found reduction in the operative time along with tourniquet time.

McGreer et al. concluded that polyester is an acceptable alternative to wire in tension-band fixation after testing comparable groups of cadaveric patellae repaired by a tension-band fixation with polyester versus 18-gauge stainless-steel wire over 20,000 cycles of knee flexion and extension. However, when subjected to tensile strains, polyester was 75% as strong as wire.

Patel et al. demonstrated on cadaveric knee specimens that several techniques, including polyester suture (no. 5 Ethibond) and stainless-steel wire, behaved comparably under certain loading conditions. They concluded that the quality of fixation of the braided polyester suture was comparable to that of stainless-steel wire for transverse patellar fractures. They extrapolated that the suture technique provided sufficient stability to withstand loads likely to be encountered during post-operative rehabilitation in vivo. Interestingly, the technique of knot tying involved initially tying with a sliding knot, as first described by Mast et al., in order to overcome the difficulty of maintaining compression force using a standard surgical knot. This technique was combined with the findings of Gerber et al. who had demonstrated that adding two additional throws could securely lock the sliding knot.

Gosal et al. demonstrated that the fracture union rate for the tension-band suture technique was not significantly different to the fracture union rate of the tension-band wire technique. However, it was suggested in that study that the complication and re-operation rate was lower for the tension-band suture group.

The main criticism of using a suture technique in comparison to using stainless-steel wire is that it cannot achieve such rigid fixation, i.e. the whole construct is more liable to fracture displacement (interfragmentary gap) at certain loads, and are more liable to dynamic creep as the suture beds into the soft tissues and bone. Patel et al. supported the use of braided polyester suture as an alternative to stainless-steel wire for fixation of displaced patellar fractures. They found that there was no fixation failure (defined as a fracture gap of greater than 3 mm), nor any significant difference between mean maximum fracture gaps for suture versus wire when the cadaveric knee specimens were tested by simulated extensions of the knee against gravity.
Harrell et al. demonstrated that multiple loops of Ethibond could be considered as a substitute for stainless-steel wire in situations where compliant repair is suitable (e.g. support of a patellar tendon repair), but less satisfactory where rigid fixation is desirable (e.g. tension-band fixation of fractures of the patella). They suggested that one possible solution to knot-settling problems, and therefore dynamic creep, would be to pull together the two objects that need to be fixed closely before tying the suture-knot. Thus, even when the knot and suture settles the two objects will be positioned correctly relative to each other. One limitation of Harrell’s study was that the mechanical properties were tested in vitro on the Instron 8500P Servo Hydraulic Material Testing System, tied over two half cylinders. The various suture configurations were tested in tension and tested to destruction. In addition, the knot chosen was a Surgeon’s Knot followed by two square knots.

A preliminary unpublished study by the authors, using a model of a transverse patella fracture (see Materials and methods section), concluded that the slip-knot technique as advocated by Patel et al. produced less interfragmentary gap versus an ordinary Surgeon’s Knot. During these preliminary studies, other suture knot-tying techniques were tested with varying success regarding interfragmentary gap. The modified Wagoner’s Hitch (see Materials and methods section) was singled out for; the low interfragmentary gap it attained on the model, its ease of tying, and its reproducibility when taught to other surgeons of comparable surgical ability.

Fortis et al. conducted a study of strains developing in the anterior and posterior patellar surfaces when a tension-band wire fixation of cadaveric transverse patellar fractures specimens was placed under cyclical loading. They showed that tightening a figure-of-eight tension-band wire would produce compressive strains of the anterior patellar surface and tensile strains of the posterior one. Interestingly, the addition of a second circular wire (cerclage) produced compressive strains on both anterior and posterior surfaces. Fortis et al. also described that during the first few degrees of flexion, the fracture line in the posterior patellar surface tends to separate, and they suggested that over-tightening produces tensile strains in the posterior patellar surface. However, if a tension-band wire is not adequately tightened, early loosening may occur. Further flexion of the knee specimens produces compressive strains of the posterior patellar surface as in the normal strain dynamics of an intact patella throughout flexion.

### Interfragmentary gap

The size of the fracture gap and the motion that occurs across it are very important concepts. Controlled axial micromotion across such gaps accelerates fracture union. However, torsional instability, excessive motion and a gap of over 2 mm are detrimental to fracture healing.

Using an experimental model of a fracture, Perren showed that there is a reduction in interfragmentary compression within the first week, but that significant levels of compression remain for up to 7 weeks, with histological evidence that the bone surfaces remain in good contact. Primary bone healing, or direct osteonal remodelling across the fracture is desirable. Whereas, gap healing, or formation of lamellar bone at right angles to the fracture, which is then subsequently remodelled, is still effective. Rigid internal fixation, such as with the tension-band technique, can produce a condition of absolute stability, and no callus formation would be expected.

Relative instability, which may be reflected in the tension-band suture fixation that shows some significant increase in interfragmentary gap over time, through either loading or knot failure or bedding-in, would show as callus formation on the X-ray. Certainly, the tension-band wire configuration will be a much stiffer construct than a tension-band suture.

As with any fracture healing there is effectively a race against time, and loss of stiffness of a construct in too short a time, before healing has occurred, may be more likely in any suture technique in comparison to those employing wire.

The strain theory of fracture healing, or the interfragmentary strain hypothesis, is that the tissue type that forms in a fracture gap that is healing is dependent on the effective strain (rather than engineering strain) it experiences. If the effective strain is less than 2%, bone will form, between 2% and 10% fibrocartilage will form, or over 10% one can expect granulation tissue.

### Materials and methods

A purpose built rig was used to test the compressive force obtainable from a braided polyester suture (no. 5 Ethibond, Ethicon) and 0.9 mm stainless-steel wire (Biomet) tied in a figure-of-eight configuration across a simulated transverse patella fracture held with two 2 mm parallel k-wires.

Wheatstone bridge strain gauges are positioned on the upright beam at right angles to the posterior surface of the model of the patella (Fig. 2). Changes
in resistance are due to the bending of the metal beam, which depends on the forces acting towards the fracture gap in line with the longitudinal or vertical axis of the patella. That is to say that the measurements taken do not correspond to interfragmentary compression directly, but as a measure of the bending moment of beam A. The upright beam on the right hand side of the patella is fixed on more rigidly and thus deforms significantly less in comparison to the more ductile beam with the strain gauges attached. However, it is the movement of beam A that has been calibrated for interfragmentary gap. The equipment was set-up as shown in the diagram (Fig. 3).

All experimental fixations and observations were performed and recorded by the corresponding author. The results were analysed by an independent statistician based at the senior author’s institution.

**Tension-band suture method 1—the modified Wagoner’s Hitch**

The Wagoner’s Hitch or Lorry driver’s Hitch is a traditional method used by lorry drivers to lash down loads. The modification described below is simpler in design but applies similar principles in that a pulley system is combined with a knot—giving a mechanical advantage on tightening. It differs in several ways: the rope or suture is double stranded; it is tied in a figure of eight (looped over parallel k-wires); the knot is finished with several square knots that are employed to lock the knot deliberately to make it permanently secure. The traditional Wagoner’s hitch is obviously designed to be undone once it has served its purpose so that loads are freed without sacrificing the rope.

The Ethibond suture was formed into a loop and a figure-of-eight was wrapped around the two longitudinal k-wires and across the anterior surface of the patella. The needle and loose end were passed through the loop, as shown in Fig. 4a.

The needle and loose end were passed over the suture to form the loop of the knot, Fig. 4b. Then the needle and loose end were passed back under the two strands that they had just been passed under and through the loop that had just been formed, Fig. 4c. This created a hitch and tightening the knot was started from the position shown in Fig. 4d. This starting position provided the most effective compression when pulling on the needle and loose end strands in the direction shown, Fig. 4d. This starting position provided the most effective compression when pulling on the needle and loose end throughout this knot tying. As the knot is slipped towards the loop at point B towards the loop shown at point A. Compression was maintained via tension on the needle and loose end throughout this knot tying. As the knot is slipped towards the loop at point B, it begins to tighten (Fig. 5). To lock the knot; the single stranded needle was passed under the knot which was finished with four square knot throws in quick succession to avoid loss of tension before the
bone-reducing forceps were released and readings were taken (Fig. 6).

In developing this new tension-band suture technique, the modified Wagoner’s Hitch (TBS1), it was found that if a certain distance was not maintained at the initial setting of the knot between the loop and the slip-knot (Fig. 4d, between points A and B), then often the knot would prematurely tighten before maximum compressive force was attained.

In addition, this knot was more likely to break if prematurely tightened.

**Tension-band suture method 2—double slip-knot**

A single strand of Ethibond suture was placed in a figure-of-eight, and two throws of a slip-knot were formed and this slip-knot was set in a starting
position. The bone-reducing forceps were clamped to a maximum, and the slip-knot was tightened towards the anterior surface of the patella. Suture-holding forceps (with smooth-surfed jaws) were utilised to slide the knot to a maximum tightness whilst maintaining tension with the other hand. Again the knot was finished with four square knot throws in quick succession to avoid loss of tension.

Controls

It was considered that a standard figure-of-eight tension-band wire technique should be included in the experiment as a control. Although there are plenty of data and literature supporting this technique, had it not been tested on the same model, then a comparative study would not be feasible. In addition, a comparative study would be less easy to interpret without a second control in the form of a maximum compressive force (minimal interfragmentary gap) achieved with bone-reducing forceps. This was assumed a realistic level of compression achievable by a surgeon of average capability and strength. This approach to a double control, one being a theoretical absolute fracture reduction (bone-reducing forceps) and the other being an established gold-standard tension-band wiring technique, would give weight to the comparative evaluation data and help to strengthen any statistical significance if found.

Results

Observations

The results for the millivolts (mV) reading in the control group (bone-reducing forceps) were as follows: the mean millivolts (mV) reading was 10.4 mV (n = 30, range 9.0–11.5 mV). This is equivalent to an interfragmentary gap of 0.02 mm using the calibration data.

The results for the tension-band suture technique 1 (TBS1, modified Wagoner’s Hitch) gave a mean value of 8.3 mV (S.D. ± 0.2, n = 15, range 8.0–8.5 mV). This is equivalent to an interfragmentary gap of 0.24 mm (S.D. ± 0.07).

The results for the tension-band suture technique 2 (TBS2, double slip-knot) showed a mean value of 3.8 mV (S.D. ± 0.5, n = 15, range 3.2–4.7 mV). This is equivalent to an interfragmentary gap of 0.80 mm (S.D. ± 0.12).

The results for the tension-band wire (TBW) technique show a mean value of 7.3 mV (S.D. ± 0.1, n = 15, range 7.1–7.6 mV). This is equivalent to an interfragmentary gap of 0.36 mm (S.D. ± 0.05).
Statistics

Refer to Table 1. Using Student’s unpaired t-test comparing TBS1 data versus TBS2 data the p-value was highly statistically significant (p < 0.001) and the null hypothesis (no difference between the fracture gap after bone-reducing forceps were released for either technique) was rejected.

Using Students unpaired t-test comparing TBS1 data versus TBW data the p-value was highly statistically significant (p < 0.001) and the null hypothesis (no difference between the fracture gap after bone-reducing forceps were released for either technique) was rejected.

Discussion

Within the limitations of this study, the results show that the interfragmentary gap attained with the new tension-band suture technique compare favourably with both ‘gold-standard’ tension-band wire and suture techniques.

The data for tension-band suture technique 1, the modified Wagoner’s Hitch, represent a smaller strain or interfragmentary gap when looking at the mean data in comparison to the slip-knot technique and the wire (p < 0.001).

The main conclusion from this study is that, within this model, the new tension-band suture technique was as effective in providing a rigid fixation construct by comparison to a ‘gold standard’ tension-band wire technique.

With regards to the problems raised in the introduction, this work fits into the background of previous investigations in that it offers an alternative suture technique to those critics of the existing slip-knot tension-band suture technique, which, incidentally, has already shown favourable clinical results. The modified Wagoner’s Hitch tension-band suture technique is suggested as an alternative method based on biomechanical properties of the construct as tested within the framework and limitations of this work. In addition to its use in transverse patellar fractures, it could also be adapted for studying tension-band suture fixation of olecranon fractures.

If there are concerns that the absolute stability required to produce primary bone healing via a stiff construct is not achievable by the existing double slip-knot tension-band suture technique as advocated by several other authors, then perhaps the modified Wagoner’s Hitch technique could be considered for further experimental testing in cadaveric dynamic testing conditions.

One of the assumptions in this dissertation is that less interfragmentary gap during fixation sets a baseline level from which the expected reduction in compression over time still allows the construct a relative stability with a functional interfragmentary gap, thus minimising interfragmentary motion. Hence, the construct would still be stiff enough to allow either primary bone healing or gap healing as discussed above. To test this assumption was beyond the scope of the thesis and would require animal models for in vivo experimentation. However, it should be noted that none of the constructs showed a gap greater than 2 or 3 mm, whichever value is taken to indicate fixation failure or unacceptable gap.13,24,26

The clinical study results have shown comparable and favourable results using tension-band suture techniques over tension-band wire.8,14,15,21,22,24 How would a different technique (the modified Wagoner’s Hitch) show any clinical advantage? A prospective randomised clinical controlled trial is the highest level of evidence available to establish any significant difference. The author suspects that the study number would have to be high and a multicentre approach would be necessary.

<table>
<thead>
<tr>
<th>Power (V)</th>
<th>BR Forceps Control (mV)</th>
<th>Tension Band (mV)</th>
<th>Interfragmentary gap (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBS1 (mWH)</td>
<td>5.65</td>
<td>10.3 (±0.6)</td>
<td>8.3 (±0.2)</td>
</tr>
<tr>
<td>TBS2</td>
<td>5.65</td>
<td>10.6 (±0.8)</td>
<td>3.8 (±0.5)</td>
</tr>
<tr>
<td>TBW</td>
<td>5.65</td>
<td>10.3 (±0.3)</td>
<td>7.3 (±0.1)</td>
</tr>
</tbody>
</table>

p-Values

- TBS1 vs. TBS2: Not significant, p < 0.001, p < 0.001
- TBS1 vs. TBW: Not significant, p < 0.001, p < 0.001
- TBS2 vs. TBW: Not significant, p < 0.001, p < 0.001

BR = bone reducing forceps, TBS1 (mWH) = tension band suture method 1 (modified Wagoner’s Hitch), TBS2 = tension band suture method 2, TBW = tension band wire method.
Conclusions

Excess displacement or interfragmentary gap in fractures during fixation adversely affects bone healing. Minimising gap or applying and retaining compression at a fracture site during fixation are important factors in optimising bone healing.

Transverse patellar fractures are optimally managed using the tension-band principle in operative fixation. Stainless-steel wire is commonly used but is associated with adverse clinical outcomes. Non-absorbable sutures are associated with fewer clinical complications.

Tension-band suture constructs are considered more liable to fracture gap displacement at certain loads. They can exhibit dynamic creep when the knot and suture bed into the soft tissues and bone; or the knot loosens.

No statistically significant advantage of one tension-band material over another has been shown in the literature—there are no powerful prospective randomised controlled trials.

The use of a modified Wagoner’s Hitch to construct a tension-band employing a braided polyester suture to reduce a model of a transverse fractured patella produced less interfragmentary gap than other well-recognised techniques.

The testing rig used in this evaluation study produced data showing statistical significance in favour of the modified Wagoner’s Hitch over a double slip-knot technique and a standard tension-band wire method.

There are limitations to this study in that it is an in vitro evaluation of surgical techniques without dynamic testing.

Further work is required before the modified Wagoner’s Hitch can be applied clinically; more extensive cadaveric dynamic cyclical testing, using other construct configurations such as additional loops or with cerclage, is recommended before clinical trials.

References


