

## Tension-band wiring of closed transverse fractures of patella; effect of site of wire twists and orientation of stainless steel wire loop

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**Objectives:** To evaluate a modified tension band Osteosynthesis wiring method for closed transverse patellar fractures and compare the outcomes with conventional tension band wiring.

**Methodology:** This prospective interventional study was conducted at Private Medical Centers, Peshawar from March 18, 2009 to March 17, 2012. Patients with closed transverse fractures of patella were consecutively allocated to two groups; In group 1 the conventional where as in group 2 the modified techniques were used. Following discharge, all patients were advised follow up at 2 weeks, 1 month, 3 months, 6 months and 12 months. Efficacy of either procedure was assessed by comparing complications, range of motion, quadriceps wasting, quadriceps power, extension lag and knee pain.

**Results:** A total of 108 patients were included in

the study. Mean age was similar in both groups ( $31.58 \pm 8.55$  and  $31.34 \pm 6.74$ ) as was the male to female ratio. On completion of three months, 16 (24.6%) patients in-group 1 presented with radiological non-union. Fifteen (23.07%) patients from both groups had gross quadriceps wasting, 11 (66.6%) of which were from group 1. At 12 months, 13 (39.39%) patients from group 1 versus 11 (34.37%) from group 2 had extension lag in comparison to the contra lateral limb. By the end of 12<sup>th</sup> months, only 7 (10.76%) had power of less than 90% comparing to the normal limb.

**Conclusion:** The modified technique had a better long-term outcome as compared to the conventional technique with cerclage wiring. (Rawal Med J 2014;39:292-296).

**Key words:** Patella, fracture, tension band wiring, quadriceps.

## INTRODUCTION

Patella is the largest sesamoid bone in the body and because of its prominent position it is prone to direct trauma accounting for over 1% of all skeletal injuries in both children and adults.<sup>1</sup> Of the several types of presentations of fractures of the patella the most common being transverse fractures secondary to trauma in adults. Transverse fractures may occur by both direct and indirect mechanisms.<sup>2</sup> Patella fractures become problematic if the extensor mechanism of the knee is nonfunctional, articular congruity is lost, and stiffness of the knee joint ensues. In order to avoid these problems, the surgeon must achieve anatomic restoration of the joint and must allow early motion.<sup>3</sup> Patellar Osteosynthesis by Tension Band wiring (as recommended by the AO group) in uncomplicated transverse fractures is considered the standard method of treatment.<sup>4,5</sup> However, complications like loss of fixation/loss of reduction in up to 20%,

prominence of hardware, stiffness and infection in the early post operative period have been reported.<sup>6</sup> A review of 49 patellar fractures found that 22% of fractures displaced more than 2 mm at the fracture site with early mobilization after tension-band wiring using the conventional technique.<sup>7</sup>

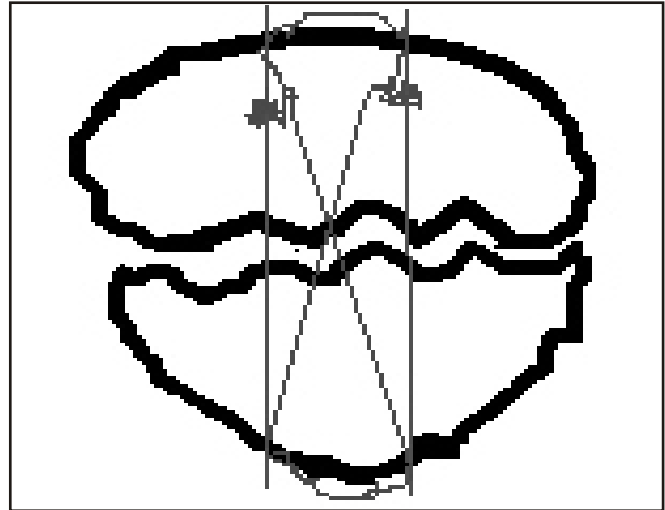
There has long been debate as to the choice of procedure yet details such as the orientation of the figure of eight tension band wire (vertical versus horizontal), number of twist(s) of wire around the K-wires and the ends of the K-wires (cut or bent) still remains a question.<sup>8</sup> The aim of this study was to evaluate the efficacy of modified technique on the outcome and compare it with conventional Tension Band Wiring, after Osteosynthesis of uncomplicated transverse patellar fractures.

## METHODOLOGY

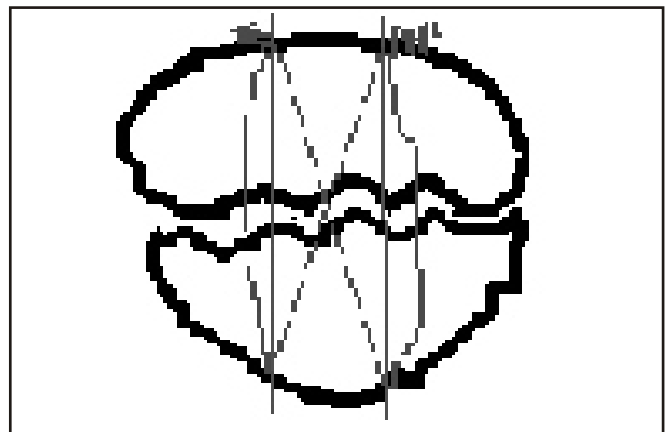
This study was conducted at Private Medical Centers of Peshawar, Pakistan from March 18, 2009

to March 17, 2012 and included patients presenting with clinical and radiological evidence of fracture of the patella secondary to trauma. Through a non-probability consecutive sampling, a prospective approach to categorizing those patients who would undergo a particular procedure was defined by the degree of comminution and displacement. A sample size could not be ascertained due to the great variability in the outcome of tension band wiring. With radiological evidence of >2mm displacement between either of the comminuted fragments, patients underwent Tension Band Wiring with cerclage. These included all closed fractures irrespective of the mode of injury or the pattern of fracture. Those patients with comminution of a degree not amenable to osteosynthesis were excluded from the study as they were planned for partial patellectomy. Also patients with open fractures and associated long bone fractures of the same limb were excluded from the study. Routine investigation to assess fitness for anesthesia was conducted and those patients in ASA III were excluded from the study. An Informed written consent was taken.

*Group 1 (conventional)* patient underwent tension band wiring with cerclage as originally described by the AO Group, including initial placement of a cerclage wire around the anterior surface of the patella apposing the comminuted segments followed by outwards-inward placement of two parallel Kirschner's wires (K-wires) extending from the superior to the inferior pole of the patella. Following this, the wires were fixed in a figure of 8 configurations with a vertical orientation and a single twist around the K-wires at corners. Apart from this at the end of the procedure the ends of the K-wires were cut. In *Group 2 (modified technique)* patients had similar cerclage wire was placed followed by placement of K-wires (parallel) and then a tension band wire placed. The tension band wire was horizontally oriented with double twist around the K-wires at corner and instead of simply cutting the K-wires at the end of the procedure the protruding K-wires is bent so as to hook the tension band wire. The tension band wires in both groups are of a non-bio-degradable stainless steel variety.



**Group 1 (Conventional)**



**Group 2 (Modified Technique)**

Patients were immobilized for 3 weeks followed by prone hang exercises at 3 weeks and crutches, which were discontinued after 6 weeks. Following discharge, all patients were advised follow up visits at 2 weeks, 1 month, 3 months, 6 months and 12 months where the requisite data was documented on a pre designed performa.

Efficacy of either procedure was assessed by comparing frequency of complications, range of motion, quadriceps wasting, quadriceps power, extension lag and knee pain.

All data were analyzed using SPSS version 13.0. All categorical data was compared using chi-square test and in a table of 2X2 will lower values, the Fisher's exact test was performed. All quantitative data was compared using Student's t test. A p=0.05 or less was considered as statistically significant.

## RESULTS

Out of 108 patients, 28 had open fracture where as 6 with closed fractures had associated fractures on the same limb and were excluded from the study. Nine patients were lost during follow up and were also excluded from the study. That left 65 patients for final analysis. The mean age in group 1 was  $31.58 \pm 8.55$  versus  $31.34 \pm 6.74$  in group 2 and mean post-operative hospital stay was longer in group 1 (Table 1).

**Table 1. Demographic data, hospital stay and post-operative pain (n=65).**

Variable	Group 1 (n=33)	Group 2 (n=32)
Age (years)	$31.58 \pm 8.55$	$31.34 \pm 6.74$
Gender (M:F)	15.5:1	15:1
Hospital stay (days) *	$4.15 \pm 2.77$	$3.5 \pm 2.2$
Pain at 12months** (visual analogue score)	$0.45 \pm 0.905$	$0.41 \pm 0.712$

**Table 2. Post-operative data (n=65).**

Variable	Group 1 (n=33)	Group 2 (n=32)	P value
Loss of reduction at 2 weeks	09 cases (27.27%)	09 cases (28.15%)	0.939
Loss of reduction at 3 months	13 cases (39.39%)	03 cases (9.37%)	0.005
Wound infection	03 cases (9.09%)	01 case (3.12%)	0.317
Prominence of hardware	12 cases (36.36%)	03 cases (9.37%)	0.010
Avascular necrosis	03 cases (9.09%)	01 case (3.12%)	0.317
Refracture in 12 months	05 cases (15.15%)	01 case (3.12%)	0.094
Post-traumatic arthritis	04 cases (12.12%)	03 cases (9.37%)	0.721

On the completion of three months 16 cases (24.6%) presented with radiological non union that was more frequent in group 1. Wound infection was higher in group 1 (9.09%) as compared to group 2 (3.12%). By the first year there were seven patients (10.7%) that developed arthritis (Table 2).

**Table 3. Quadriceps diameter in comparison to contra lateral limb.**

Quadriceps wasting	Group 1 (n=33)	Group 2 (n=32)	P value
At 2 weeks (cm)	$0.48 \pm 0.854$	$0.15 \pm 0.34$	0.046
At 1 month (cm)	$0.76 \pm 1.53$	$0.95 \pm 1.56$	0.613
At 3 months (cm)	$1.23 \pm 2.125$	$0.66 \pm 1.532$	0.220
At 6 month (cm)	$1.79 \pm 2.759$	$0.50 \pm 1.586$	0.025
At 12 months (cm)	$1.85 \pm 3.68$	$0.47 \pm 1.95$	0.065

At 6<sup>th</sup> month of follow-up, 15 patients (23.07%) from both groups had gross quadriceps wasting, 11 (33.3%) of which were from group 1. But at 12 months, this was again reverted only to be higher in group 1 but the difference was insignificant. (Table 3).

**Table 4. Sum of degree of extension lag post-operatively.**

Extension Lag	Group 1 (n=33)	Group 2 (n=32)	P value
At 2 weeks ( $^{\circ}$ )	$17.36 \pm 15.47$	$10.63 \pm 16.88$	0.098
At 3 months ( $^{\circ}$ )	$11.15 \pm 11.7$	$4.56 \pm 7.87$	0.01
At 12 months ( $^{\circ}$ )	$5.64 \pm 8.67$	$2.19 \pm 5.67$	0.063

At each observation, the frequency of patients was higher as was the sum of the degree of extension lag in group 1. At 12 months, 13 patients (39.39%) from group 1 versus 11 patients (34.37%) from group 2 had extension lag in comparison to the contra lateral limb (Table 4).

**Table 5. Quadriceps power of patients post-operatively.**

Quadriceps power	Group 1 (n=33)	Group 2 (n=32)	P value
At 2 weeks (%)	$73.06 \pm 18.12$	$72.44 \pm 18.88$	0.892
At 3 months (%)	$87.67 \pm 13.5$	$87.44 \pm 15.71$	0.950
At 12 months (%)	$94.24 \pm 9.6$	$95.31 \pm 10.15$	0.665

By the end of 12<sup>th</sup> month, only 7 patients (10.76%) had power of less than 90% comparing to the normal limb. There was no significant difference between both groups in terms of power loss compared to the normal limb.

## DISCUSSION

Although studies showing partial or total removal of the patella leading to degrees of functional loss in the range of 19-33%,<sup>10</sup> the aim has been to conserve it. This emphasizes the fact that patella transmits tensile forces generated by the quadriceps to the patellar ligament and increases the effective lever arm of the knee extensor mechanism from the axis of knee flexion and extension.<sup>11</sup>

In this study, it was demonstrated that the interfragmentary compression of vertical figures of eight showed an increasing trend changing from one twist of wire to two twists of wire arbitrarily placed along the loop, to two twists of wire placed at adjacent corners of the figure of eight and changing the orientation of the figure of eight from vertical to horizontal. The aim of this surgery is to keep the comminuted fragment at place so that they show greater interfragmentary strength to unite.<sup>12</sup> The forces that act at the fracture site after fixation are either a distraction force due to the action of the quadriceps in extension or three-point bending that occurs at knee flexion. The three-point bending is essential for the tension band principle to work. Greater interfragmentary compression not only helps bone healing but is also a measure of resistance to displacement at the fracture site secondary to distraction forces generated by the quadriceps in extension. Considering this, the position of the cerclage wire and the K-wire closer to the anterior surface of the patella is mandatory.<sup>12</sup>

Several experimental models earlier have generated the picture that the orientation of the tension band wire from a vertical to a horizontal position and even more so bending of the ends instead of cutting them will lead to more interfragmentary strength.<sup>13,14</sup> This was significantly observed in this study, where at 3 months of follow up only three patients showed radiological non-union. This is still a high figure in comparison to literature. The possible explanation could be non compliance at immobilization in the early post operative period. The gap between the segments was considered displaced on 2mm or more distance although other authors may disagree.

In this study, there was no great variation between

the two groups based on demographics, the length of hospital stay or the developments of any of the early complications.<sup>15,16</sup> There was a statistically significant greater complaints of prominence of hardware following the conventional procedure earlier described. The early complication rate of tension band wiring ranges from 0% to 25%<sup>17</sup>.

The other aim of our study was to assess the functional outcome of the knee following the two techniques.<sup>18</sup> There was no major difference between the number of cases found to have a loss of diameter of the quadriceps muscle following either procedure yet their sums varied greatly and a higher sum was recorded at 6 months in group 1 following the conventional procedure and was found to be statistically significant. This high sum of muscle wasting was seemingly maintained in the coming months as this was also observed at the 12<sup>th</sup> month but was not significant ( $p=0.065$ ). Studies of longer duration may elucidate the long-term prospect of this discussion.<sup>19</sup>

Using a goniometer, the active extension was recorded with range of motion in comparison to the other limb that revealed a statistically significant difference in the sum of the extension lag between the two groups as there was a greater lag in group 1. This was not significant in the 12<sup>th</sup> month. Cross tabulation with postoperative pain also revealed no significant association. To rule this effect as a result of post-operative pain is inconclusive in this study.

A technique for fixing minimally displaced patellar fracture using a percutaneous tension band wiring was described by Biyani et al.<sup>20</sup> The debate to the technique for open repair tension band wiring with its modifications with respect to outcome is never ending yet the trends of moving to a more minimally invasive procedure are a matter of debate in this region.

## CONCLUSION

The modified technique of tension band wiring described in this study for the treatment of closed patellar fractures had a lower frequency of complications related to the procedure compared to the conventional technique of tension band wiring.



**Author contributions:**

Conception and design: Sardar Sohail Afsar  
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 Analysis and interpretation of the data: Sardar Sohail Afsar, Mohammad Gulzar  
 Drafting of the article: Mohammad Idrees  
 Critical revision of the article for important intellectual content: Iqtidar ullah Babar  
 Statistical expertise: Sardar Sohail Afsar, Mohammad Idrees  
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