

Comparative Study

SUTURE FIXATION VERSUS METALLIC CERCLAGE FOR ARTICULAR PATELLAR FRACTURE: A MINIMUM 1-YEAR, RETROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Surgical treatment of patellar fractures with traditional metallic wires results in high rates of complications, with many patients requiring reoperations. Non-metallic implants for the fixation of patellar fractures have shown promising results. This study compares the outcomes of surgical fixation of patellar fractures with metallic wires to suture fixation. Patients with closed patellar fractures requiring surgical fixation were treated with 1.25 mm cerclage wire or suture fixation. Inclusion criteria were fractures with an intra-articular step-off >2mm, displacement >4mm, or impairment of the extensor mechanism. Outcomes were Kujala and WOMAC scores, ROM, and prevalence of postoperative complications. Failure was defined as the need for revision surgery, loss of reduction, malunion or non-union, or poor outcome. The radiographic examination assessed patellar height, radiographic union, secondary displacement, and implant breakage. Thirty-eight patients underwent surgical fixation with metallic cerclage wire, while 32 patients underwent suture fixation with a mean follow-up of 46.6 ± 24.2 (range: 12 to 100) months. No clinical or radiological differences were seen at the final follow-up evaluation. No significant differences among reported complications were found. Patients who underwent metallic fixation experienced significantly higher reoperation rates ($p < 0.001$). Surgical fixation of displaced articular patellar fractures showed no significant differences in complication rates and clinical and radiographical outcomes when treated with metallic cerclage wires compared to suture fixation. However, patients treated with metallic wire fixation had significantly higher reoperation rates. Further studies are requested to thoroughly investigate the results and indications of suture fixation.

KEYWORDS: *patellar fracture, surgical fixation, metallic cerclage wire, fibrewire® suture, symptomatic hardware*

INTRODUCTION

The patella is the largest sesamoid bone of the musculoskeletal system and plays a key role in the extensor mechanism. Patellar fracture is a relatively uncommon injury of the lower limb, representing 1% of all fractures in adults with increasing incidence in the general population (1).

Over the years, several strategies and surgical techniques have resulted in high union rates (2). However, surgical treatment of patellar fractures with traditional metallic wires has high rates of complications ranging from 18 to 50%,

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with many patients requiring reoperation (3, 4). Typical complications include broken implants, migrating wires, and irritation due to symptomatic implants (5, 6). For these reasons, different authors promoted non-metallic implants or non-absorbable suture materials for the fixation of patellar fractures, showing promising results (7-10). Despite the growing interest in new materials for treating patellar fractures, only a few studies report comparative results of metallic implants and non-absorbable suture fixation for articular displaced patellar fractures.

This study aims to compare clinical and radiographic outcomes, complications, and reoperation rates of consecutive series of patients who required surgical fixation of a patellar fracture with metallic wires or suture fixation.

MATERIAL AND METHODS

Medical records of patients diagnosed with patellar fractures treated at a single University hospital from January 2013 to September 2021 were retrospectively reviewed.

Inclusion criteria were closed articular patellar fractures with intra-articular step-off greater than 2 mm, fracture displacement greater than 4 mm, or impairment of knee extensor mechanism. Exclusion criteria were open fractures, non-displaced fractures, polytrauma patients, pluri-fractures, previous surgeries on the affected knee, incomplete medical records, and patients medically unfit for surgery.

Patients were divided into two groups according to fixation method: one group treated with 1.25 mm metallic cerclage wire and one group treated with suture fixation with n.5 fiberwire® (Arthrex Inc, Naples, FL, USA). Data from two groups of patients were compared. The study size was determined based on the number of patients that met the inclusion criteria within the single university hospital between the dates of interest. All medical records and surgical details were retrieved, and data on age, sex, BMI, smoking status, previous surgeries, therapies, and comorbidities were collected.

The preoperative Charlson's index (11) was calculated to identify patients' comorbidity conditions at surgery. All the fractures were classified according to the AO/OTA classification (12). Surgical procedures were performed by four different trained orthopedic surgeons (>100 procedures per year) using the standardized surgical technique. The surgical technique and fixation method were based on surgeon preference.

The cohort studies have been evaluated using the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines (13).

Surgical technique and postoperative indications

Open reduction and internal fixation were performed through a midline longitudinal approach centered over the patella. The knee joint and fracture site were irrigated and cleared of blood clots and small debris. Fracture reduction was obtained using Weber clamps and monitored by fluoroscopy and palpation of the retropatellar articular surface through a small arthrotomy to avoid minor step-off.

Metallic fixation was completed with two 1.25 mm cerclage wires (deep and superficial) properly tightened and twisted. Suture fixation was completed with two n.5 fiberwire® (Arthrex Inc, Naples, FL, USA) and manually tightened and locked with a sliding self-locking knot. Final fluoroscopy through 60-degree range of motion was completed before wound closure to assess fixation stability.

The postoperative protocol was the same for the two groups: full weight-bearing with crutches was allowed with a knee brace locked in extension for 3 weeks. Progressive passive range of motion was encouraged after 3 weeks, and active range of motion was allowed at 6 weeks. The knee brace was removed after 8 weeks, and quadriceps strength exercises were prescribed.

Patient assessment

Patients were called to be clinically assessed at the final follow-up by two blinded orthopedic residents using the Kujala Score (14) and Western Ontario and McMaster Universities Arthritis Index (WOMAC) (15). The visual analog scale (VAS) (16) was used to assess the maximum subjective level of pain. Subjective satisfaction was investigated using a rating scale ranging from 0 (no benefits) to 10 (maximum satisfaction). The total range of motion, flexion or extension deficit, or lack of extension was clinically assessed. The blinding of the orthopedic residents during clinical assessments was included to reduce potential observer bias.

The prevalence of postoperative complications was also investigated and analyzed. Failure was defined as the need for revision surgery, loss of reduction, malunion, non-union, or poor clinical outcome.

A radiographical examination at the final follow-up was performed, and patellar height, radiographic union, secondary displacement, or implant breakage were assessed. Union was defined as the absence of visible fracture gap formation and the disappearance of the fracture line.

Statistical analysis

A *post-hoc* calculation was performed, considering the reoperation rate as the primary outcome measure for the binomial endpoint and two independent sample studies. The resulting *post-hoc* power of the present study on 70 patients with an alpha value of 0.05 was 98.6%, demonstrating an adequate sample size. Categorical variables were expressed as the absolute number of cases and/or percentage. The Shapiro-Wilk Test was used to identify normally distributed parameters. Differences between means were calculated with independent samples T-test for continuous variables and with the Mann-Whitney U test if not normally distributed. Categorical variables were calculated using Fisher's exact test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 185 patients were screened for study eligibility related to patellar fracture between 2013 and 2021. Fifty-seven patients underwent conservative treatment, 7 patients had incomplete medical records, and 51 were excluded as not meeting the inclusion and exclusion criteria. Patients were called to be clinically and radiographically assessed, and no patient declined or was lost at the final follow-up.

A total of 70 patients who underwent surgical fixation of articular fracture were finally included and were clinically and radiographically assessed for the present study. Thirty-eight (54.3%) patients underwent double 1.25 mm metallic cerclage wire, and thirty-two (45.7%) underwent suture fixation with fiberwire® n. 5 (Arthrex Inc, Naples, FL, USA) cerclage (Fig. 1).

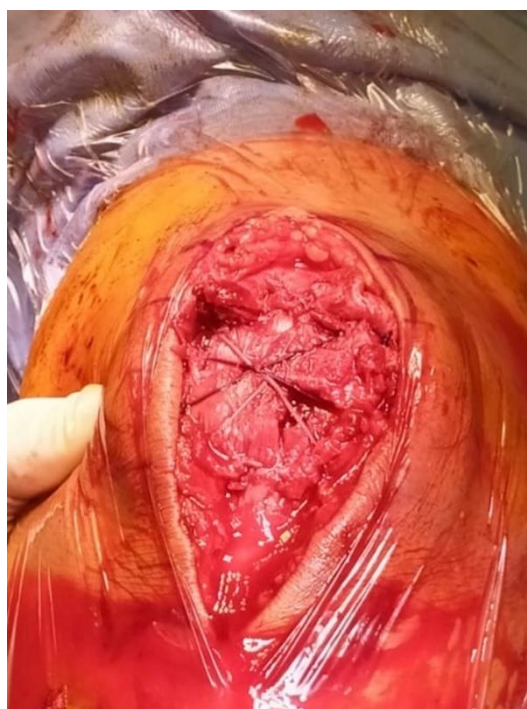


Fig. 1. Intraoperative view of suture fixation of the patellar fracture with n. 5 fiberwire® suture.

The mean follow-up was 46.6 ± 24.2 (range: 12 to 100) months without significant differences in demographic parameters among groups ($p > 0.05$). Table I shows the general features of the study population.

Table I. Demographics and general features of the overall population (N=70) who underwent surgical fixation of the patellar fracture with metallic cerclage wire (n=38) and fiberwire cerclage (n=32).

	Surgical technique		p-value
	<i>Metallic wire</i>	<i>Suture fixation</i>	
Number of patients	38	32	-
Age at surgery (years)	60.9 ± 18.6 (19 to 83)	57.9 ± 18.1 (22 to 87)	0.412 ^a
Gender (female/male)	24/14	25/7	0.173 ^b
Smoking status (yes/no)	9/29	5/27	0.551 ^b
Cigarettes/day	2.8 ± 5.0 (0 to 15)	2.8 ± 6.8 (0 to 20)	0.454 ^a
BMI	23.5 ± 2.6 (19 to 29)	22.4 ± 3.2 (17.5 to 28)	0.086 ^c
CCI	2.6 ± 2.1 (0 to 8)	2.4 ± 2.3 (0 to 9)	0.492 ^a
Follow-up (months)	50 ± 27.3 (12 to 100)	40.5 ± 19.1 (12 to 68)	0.129 ^a

Continuous variables are expressed with main values, standard deviation, and range of values (in brackets). Absolute values are expressed by frequencies: ^a=Mann-Whitney U test; ^b=Fisher's exact test; ^c=Student's t-test. **BMI**: Body Mass Index; **CCI**: Charlson Comorbidity Index.

There were no clinical and radiological differences at the final follow-up evaluation among patients treated with metallic wire and suture fixation technique (p>0.05). Table II shows the assessed clinical outcome measures. There were no significant differences among reported complications at the final follow-up assessment (p>0.05) (Table III).

Table II. Clinical outcome results at final follow-up assessment.

	Surgical technique		p-value
	<i>Metallic wire</i>	<i>Suture fixation</i>	
Kujala score	85.3 ± 14.1 (55 to 100)	87.8 ± 14.6 (42 to 100)	0.254 ^a
Womac score	85.5 ± 13.4 (44.5 to 100)	85.7 ± 13.5 (44.5 to 99)	0.962 ^a
Vas _{max}	2.5 ± 2.6 (0 to 9)	2.6 ± 2.4 (0 to 10)	0.173 ^a
Subjective satisfaction	7.1 ± 2.7 (1 to 10)	7.1 ± 2.6 (0 to 10)	0.957 ^a
Complications	6 (15.8%)	7 (21.8%)	0.552 ^b
Re-operation	16 (42.1%)	1 (3.1%)	<0.001^b

Continuous variables are expressed with main values, standard deviation, and range of values (in brackets). Absolute values are expressed by frequencies and relative percentages (in brackets). Bold values indicate significant differences. ^a=Mann-Whitney U test; ^b=Fisher's exact test. **BMI**: Body Mass Index; **CCI**: Charlson Comorbidity Index.

Table III. Details of complications reported at the final follow-up.

Complications	Surgical technique		p-value
	<i>Metallic wire</i>	<i>Suture fixation</i>	
Stiffness	1 (2.6%)	4 (12.5%)	0.171 ^a
Implant breakage	2 (5.3%)	0 (0%)	0.497 ^a
Secondary displacement	2 (5.3%)	2 (6.3%)	1.000 ^a
Patella alta	0 (0%)	0 (0%)	1.000 ^a
Patella baja	1 (2.6%)	1 (3.3%)	1.000 ^a
Non-union	0 (0%)	1 (3.1%)	0.457 ^a

Absolute values are expressed by frequencies and relative percentages (under parenthesis). ^a=Fisher's exact test.

Patients who underwent metallic fixation experienced a significantly higher reoperation rate (42.1%) due to symptomatic hardware ($p < 0.001$).

Potential confounders include the following: demographic information, which has been deemed to be statistically insignificant; fracture severity and location, which are variables minimized through the inclusion criteria provided; surgical experience and technique of the four trained surgeons, which has been aimed to be reduced based on the sample size and randomization; postoperative care, for which a uniform guideline has been provided across both cohorts; access to rehabilitation, adherence to rehabilitations, and differences in physical activity between patients, which again has been aimed to be reduced based on sample size and randomization.

DISCUSSION

The main finding of the present study is that surgical fixation of displaced articular patellar fractures with metallic cerclages or fiberwire® suture fixation had similar clinical and radiographic outcomes and comparable complication rates. However, patients who underwent metallic fixation had a significantly higher reoperation rate for symptomatic hardware removal.

The patella plays a key role in the extensor mechanism, and the operative fixation techniques and materials used to treat patella fractures are constantly evolving (1, 3, 17-19).

The compression at the fracture site represents the mainstay of internal fixation to promote healing of patellar fractures and to restore the extensor mechanism function (20). However, a high rate of complications related to metallic fixation has been reported (4). Metallic wires may cause irritation, pain, implant breakage, migration, and a high rate of reoperation due to symptomatic hardware. Alternative solutions for the internal fixation of patellar fractures have been investigated to reduce hardware-related complications (7).

Few clinical studies with limited populations (3, 7, 8, 19, 21, 22) compare mid-term outcomes of suture materials and metallic wires for patellar fractures, and additional evidence is requested.

Wright et al. (23) conducted a biomechanical study in 2009 that showed that at higher tensile forces (>250N), fiberwire® had superior failure strength than conventional stainless steel, justifying the *in-vivo* application of suture materials to decrease re-operation rate and enhance patient satisfaction.

Monaco et al. (17) conducted a retrospective analysis evaluating 26 patients affected by transverse patellar fractures at 18 months and comparing the suture tape to metallic wire circumferential cerclages. With the limitation of the short follow-up and the limited sample size, the authors concluded that the two techniques had comparable clinical and radiographical outcomes without differences in re-operation rates and complications.

Lee et al. (18) prospectively compared 1-year results of 60 patients who underwent multiple nonabsorbable Ethibond 2-0 suture fixation and metallic tension band fixation for articular patellar fractures, reporting a significant difference at 3 months with better clinical outcome in the suture group, and higher knee flexion in the tension band group. Moreover, the authors reported a 40% reoperation rate in the metallic tension band group compared to 0% in the suture fixation group. Despite the promising results, the clinical outcome could have been significantly biased by different

rehabilitation protocols, resulting in slower flexion progression in the suture group and more aggressive rehabilitation in the tension band group.

The present comparative study represents the largest series comparing clinical and radiological results at a mean 5-year follow-up of a homogeneous population affected by articular patellar fractures. With the same rehabilitation protocol, clinical results and complication rates were comparable between groups and in line with the published literature. However, there was a significantly higher reoperation rate in the metallic wire group, leading to significant conclusions.

This study is a retrospective single-center investigation that, although having blinded assessment, has the intrinsic limitation related to study design. Moreover, surgical procedures were performed by four different surgeons who, although well-trained, could potentially influence the outcomes.

This is a preliminary study, and no strong recommendations can be made. Further prospective randomized trials are requested to thoroughly investigate comparative results and indications of suture fixation for patellar fractures.

CONCLUSIONS

Surgical fixation of displaced articular patellar fractures showed no significant differences in complication rates and clinical and radiographical outcomes when treated with metallic cerclage wires compared to fiberwire® suture fixation. However, patients treated with metallic wire fixation had significantly higher reoperation rates than those treated with fiberwire® suture fixation. Further studies are requested to thoroughly investigate the results and indications of fiberwire® suture fixation.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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