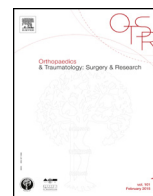




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Review article

Arthroscopically assisted fixation is a reliable option for patellar fractures: A literature review



S. Cerciello^{a,b,*}, M. Cote^c, S. Lustig^d, F. Dyrna^c, L. Pauzenberger^c, P. Neyret^d,
 A.D. Mazzocca^c

^a Casa di Cura Villa Betania, Via Piccolomini 27, 00165 Rome, Italy

^b Marrelli Hospital, Via Gioacchino da Fiore, 0962 Crotona, Italy

^c Department of Orthopaedic Surgery, University of Connecticut, 263 Farmington Avenue, Farmington, Connecticut, USA

^d Albert-Trillat Center, Lyon North University Hospital, 103, grande rue de la Croix-Rousse, 69004 Lyon, France

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ABSTRACT

Proper reduction and stable fixation of articular fractures is essential for an early recovery and to avoid late complications. Arthroscopically assisted techniques for minimally invasive fixation have been introduced to reduce local morbidity and improve anatomic reduction of the fragments. However up to date no clear indications for surgery have been given. In addition, the precise rates of functional outcomes and complications are controversial. The hypothesis was the systematic analysis of the available literature would provide precise indications, outcomes and complications of arthroscopically assisted techniques for patellar fracture fixation. A comprehensive literature review was performed using the keywords "patellar fracture", "arthroscopy" with no limit regarding the year of publication. All the selected articles were in English language and were evaluated with the Coleman score by three independent surgeons. The interclass correlation coefficient between the three examiners was calculated. Six full text articles were retrieved. The initial cohort included 60 patients with a displaced transverse fracture in the majority of the cases. At an average FU of 27.2 months the Lysholm score was 91.3. The rate of complication was 7%; Average Coleman score for the three observers was 55.8 ± 6.5 with an ICC of 0.89, indicating adequate inter-rater agreement. Arthroscopically assisted techniques for minimally invasive fixation of patellar fractures represent a reliable option. The positive clinical outcomes and low rates of complications must be confirmed with further studies including larger series and longer FU.

Level of evidence: Level IV, systematic review of retrospective series.

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1. Introduction

Patellar fractures represent 1% of all fractures in adult patients [1]. Most common patterns are vertical and horizontal fractures with or without displacement of the fragments. Transverse patellar fractures represent the most common pattern usually affecting patients aged from 20 to 50 [2], and are almost twice as frequent in men as they are in women [3]. Conservative treatment has been advocated in case of non-displaced and non-comminuted fractures. Potential disadvantages include stiffness or fragment displacement as a consequence of wrong timing in patient mobilization [4]. Conversely, displacement of the fragments or articular incongruence requires surgery. Open reduction and internal fixation, ensure

anatomical reduction of the articular surface and stable fixation [5]. Fractures of the distal pole have been successfully addressed with anchor suturing [6]. Open approach is associated with specific and general complications in up to 60% of cases [7]. These include infections (up to 14%) [8], delayed wound healing (up to 8%) [3], patellar necrosis from blood damage, and peripheral nerve disturbance especially of the branches of the saphenous nerve [9], broken wires (up to 25%) [8], irritation from the devices (up to 43%) [10], migration of Kirschner wires and hardware or fixation failure (up to 7%) [8] with reported revision rate varying from 7% to 43% [3,8,11,12]. Minimally invasive and percutaneous techniques have been introduced to reduce the rate of these complications and to achieve shorter hospitalization, better knee mobility and improved outcomes [10]. However, a potential drawback of minimally invasive techniques is the poor control of anatomic reduction of the articular surfaces. Arthroscopically assisted techniques should reduce the risk of non-anatomic fixation and late onset of patella-femoral arthritis. However up to date, there is no general consensus

* Corresponding author at: Casa di Cura Villa Betania, Via Piccolomini 27, 00165 Rome, Italy.

E-mail address: Simone.cerciello@me.com (S. Cerciello).

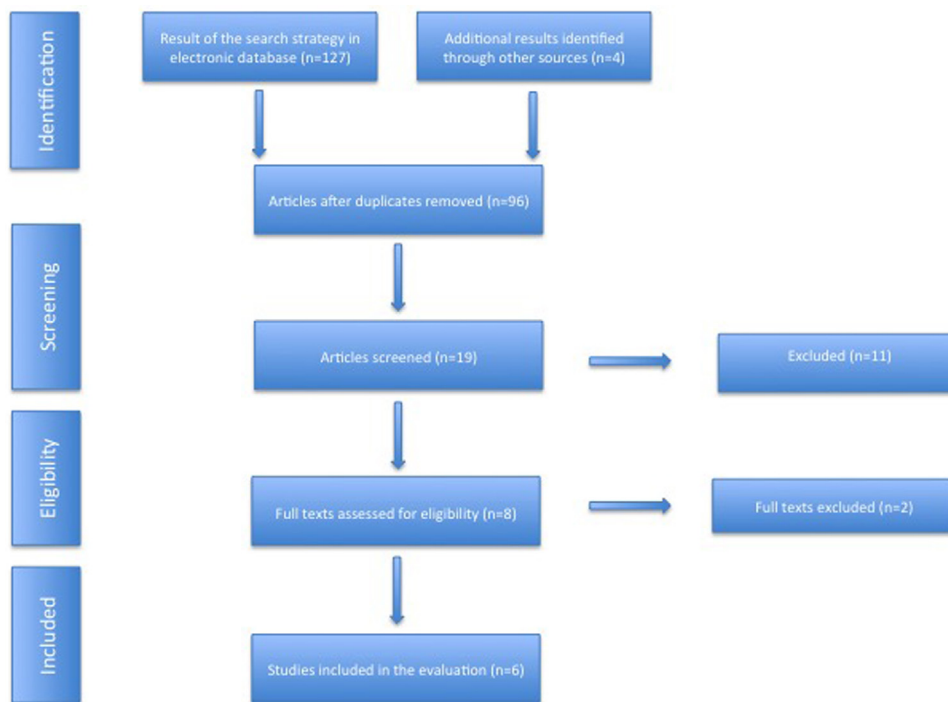


Fig. 1. Flow-chart diagram shows the recruitment and selection process of the available literature.

regarding the indications for these arthroscopically assisted techniques. In addition, there is no clear data regarding functional outcomes and specific complications related to these techniques.

The aims of the present systematic review were to analyze the available literature to clarify the aforementioned aspects: precise indications for arthroscopically assisted reduction and fixation of patellar fractures, evaluation of functional outcomes and report possible technique-specific complications. In addition the quality of the studies were assessed with the Coleman Methodology Score [13], which has been demonstrated a reliable tool to determine the methodological quality of scientific studies. The hypothesis was the systematic analysis of the available literature would provide precise indications, outcomes and complications of arthroscopically assisted techniques for patellar fracture fixation.

2. Materials and methods

A systematic literature review using the following key word terms and Boolean operators “patellar fracture” AND “arthroscopy” with no limit regarding the year of publication was performed. The following databases were accessed on 29 October 2015: PubMed (<http://www.ncbi.nlm.nih.gov/sites/entrez/>), Ovid (<http://www.ovid.com/>), Cochrane Reviews (<http://www.cochrane.org/reviews/>), and Google Scholar (<https://scholar.google.com/>). One hundred and thirty-one publications were identified. All of the abstracts were reviewed by a single surgeon. The full text manuscripts were retrieved according to the subject of the abstract text and only English language articles were included. In addition, the reference lists of the full text included were manually searched to include articles not identified at the electronic search. All journals were considered in this review and all relevant articles were retrieved. Only articles in peer-reviewed journals were considered. Prospective or retrospective studies reporting clinical outcomes were included in the study, whereas technical notes were excluded (Fig. 1).

Ultimately, 8 articles met inclusion criteria. One article was excluded as outcomes were reported incomplete [14] although the

indications for surgery and the surgical technique were recorded and would have matched the inclusion criteria. Two studies from the same surgeon reported similar data, raising the doubt of referring to the same cohort of patients [15,16]. Therefore, the data from the case series study were not included in the analysis [15]. However, both of them were included for methodological assessment. This evaluation was performed according to the Coleman Methodology Score (CMS) [13]. It is a 10 criteria evaluation form, which assesses the methodological quality of scientific studies. A perfect score of 100 represents a study design that largely avoids the influence of chance, various biases, and confounding factors. Although no cut-off for the definition of high- or low-quality studies has been previously set, a total score greater than 65 is usually accepted as the inferior limit for a high quality study [17]. Three surgeons carried out the evaluation independently.

2.1. Statistical analysis

The three versions of the CMS were then compared and the interclass correlation coefficient (ICC) between the three results was calculated. An a priori ICC value of 0.75 was selected as adequate agreement between raters.

3. Results

3.1. Coleman methodology score

All studies were evaluated according to the Coleman score criteria by three independent surgeons (Table 1). The average methodological score for the first surgeon was 63.3 (39–73), for the second surgeon was 51.7 (22–79) and for the third surgeon was 52.3 (24–79). The most lacking domain were the study size and length of FU since most of studies were case series involving only a small number of patients and short FUs. The ICC between the three surgeons for the grading of the CMS was 0.89, indicating adequate inter-rater agreement.

Table 1
Coleman methodology score.

	Authors	Study size	Mean follow-up	Number of different surgical procedures	Type of study	Diagnostic certainty	Description of surgical procedure	Description of postoperative rehabilitation	Outcome criteria	Procedure for assessing outcomes	Description of subjects election process	Total
Observer 1	Tutgut et al. [18]	0	5	10	0	5	5	10	2	5	10	57
	Makino et al. [19]	0	2	10	0	5	5	0	2	0	10	39
	Tandogan et al. [20]	0	5	0	0	5	5	10	10	8	15	63
	Yanmis et al. [21]	0	2	10	0	5	5	10	10	11	15	73
	El-Sayed and Ragab [22]	0	5	10	10	5	5	10	10	8	10	73
	Chiang et al. [15]	4	5	10	0	5	5	10	10	12	15	71
	Chiang et al. [16]	4	5	10	0	5	5	10	10	8	10	67
	<i>Average</i>	1.1	4.1	8.6	1.4	5	5	8.6	7.7	7.4	12.1	63.3
	<i>Standard deviation</i>	1.9	1.5	3.8	3.8	0	0	3.8	3.9	4	2.7	12.2
	Observer 2	Tutgut et al. [18]	0	5	10	0	5	5	10	0	5	0
Makino et al. [19]		0	2	10	0	5	5	0	0	0	0	22
Tandogan et al. [20]		0	5	0	0	5	5	5	10	11	3	44
Yanmis et al. [21]		0	2	10	0	5	5	10	8	11	0	51
El-Sayed and Ragab [22]		0	5	10	10	5	5	10	10	11	13	79
Chiang et al. [15]		4	5	10	0	5	5	10	10	10	15	74
Chiang et al. [16]		4	5	10	0	5	5	10	10	15	10	74
<i>Average</i>		0.7	4	8.3	1.7	5	5	7.5	6.3	8	5.2	51.7
<i>Standard deviation</i>		1.6	1.5	4.1	4.1	0	0	4.2	5	4.6	7	21.5
Observer 3		Tutgut et al. [18]	0	5	10	0	5	5	10	0	5	0
	Makino et al. [19]	0	2	10	0	5	5	0	2	0	0	24
	Tandogan et al. [20]	0	5	0	0	5	5	5	10	11	3	44
	Yanmis et al. [21]	0	2	10	0	5	5	10	10	11	0	53
	El-Sayed and Ragab [22]	0	5	10	10	5	5	10	10	11	13	79
	Chiang et al. [15]	4	5	10	0	5	5	10	10	10	15	74
	Chiang et al. [16]	4	5	10	0	5	5	10	10	15	10	74
	<i>Average</i>	0.7	4	8.3	1.7	5	5	7.5	7	8	5.2	52.3
	<i>Standard deviation</i>	1.6	1.5	4.1	4.1	0	0	4.2	4.7	4.6	7	21

Table 2
Demographic data.

Author	Type of study	Preoperative diagnosis	Initial cohort	Mean patient age (years) (Sg/Cg)	Sex (M/F) (Sg/Cg)	FU (months)
Turgut et al. [18]	Case series Retrospective	Displaced transverse	11	38 (26–53)	9/2	32 (18–51)
Makino et al. [19]	Case series Retrospective	Displaced transverse	5	41	4/1	18 (10–31)
Tandogan et al. [20]	Case series Retrospective	Variable	5	53 (27–74)	3/2	28 (24–35)
Yanmis et al. [21]	Retrospective	Comminuted	5	32.5 (24–42)	5/0	22 (20–28)
El-Sayed and Ragab [22]	Case series Prospective	Displaced transverse	14	34 (19–52)	14/0	26
Chiang et al. [16]	Retrospective	Displaced transverse	20 (Sg) 40 (Cg)	Sg 56.6 Cg 60.2	Sg 9/11 Cg 15/25	37.3

Sg: study group; Cg: control group; M: male; F: female.

Table 3
Procedure, outcomes and complication.

Author	Delay injury/surgery hours	Procedure	Outcome measure	Postoperative outcome	P-value (Sg/Cg)	Complications
Turgut et al. [18]	na	K-wires + cerclage	na	na	na	0%
Makino et al. [19]	na	Cannulated screws + cerclage	na	na	na	0%
Tandogan et al. [20]	76 (24–120)	Cannulated screws (n.3) Cannulated screws + cerclage (n.2)	Lysholm	84.8	na	20%
Yanmis et al. [21]	na	External fixator	Lysholm	94	na	0%
El-Sayed and Ragab [22]	55 (24–95)	Cannulated screws	Lysholm	93	na	na
Chiang et al. [16]	15.2 Sg Cg	Cannulated screws + cerclage	Lysholm	Sg 93.6 Cg 88.8	$P < 0.01$	Sg 15% Cg 75%

Sg: study group; Cg: control group; na: not available.

3.2. Demographics

Six full texts were retrieved, including 5 case series and one retrospective comparative study. Demographic data are summarized in Table 2. Initial cohort included 60 patients. In the study by Chiang et al., the study group was compared with a control group of 40 patients treated with open tension band wiring [16]. Mean age at the time of surgery was 42.5 years (range 19–82). There were 44 males and 16 females included. Surgical procedure was performed 48.8 hours after the initial trauma (range 8–120). At a mean FU of 27.2 months (range 10–51) all patients were reviewed for either clinical or imaging evaluation.

3.3. Fracture pattern

The most common indication for an arthroscopically assisted minimally invasive fixation technique was a displaced transverse patellar fracture [3,5,6,16,22], however the pattern was more complex in two studies including comminuted fractures [21] and either vertical, or distal pole, proximal pole, transverse or comminuted fractures [20].

3.4. Surgical procedure

The index procedure consisted in fracture fixation through a minimally invasive approach with cannulated screws, cannulated screw and cerclage [16,19,20,22], Kirschner wires and cerclage [18] or external fixator [21] (Table 3). In all cases the quality of reduction as well as the presence of any additional intra-articular involvement was assessed under arthroscopic control.

3.5. Clinical and radiological results

The outcomes were reported in terms of Lysholm score in all studies with the exception of the one by Turgut et al., who only reported radiographic outcome [18] (Table 3). Mean Lysholm score at FU was 91.3 (range 84.8–94). In the series by Chiang et al., the Lysholm score of the study group (93.6) was statistically superior ($P < 0.001$) to those of the control group (88.8) [16]. El-Sayed et al. reported no evidence of osteoarthritis at last FU evaluation [22].

3.6. Complications

The rate of complications was 7% (Table 3). In the one comparative study, there was a statistically significant difference ($P < 0.001$) in the rate of complications between the arthroscopically assisted procedure (15%) and the traditional open approach (75%) [16]. Reported complications included reduced primarily loss of ROM [20,22], and irritation [16].

4. Discussion

To our knowledge, the present study is the first systematic review focusing on the indications, outcomes and complications of arthroscopically assisted minimally invasive techniques for patellar fractures fixation. The most important finding of the present review is the low complications rate associated with minimally invasive reduction and arthroscopically assisted fixation of patellar fractures. The methodology of the available literature was assessed through the Coleman Score. The score obtained from the three surgeons showed a moderate methodological quality of the literature on the issue with the majority of the studies being case series with small number of patients.

Sattler et al. were the first to describe the advantages of an arthroscopically assisted reduction and a percutaneous fixation in case of displaced transverse patellar fractures [23]. This technique ensured precise visualization of the fragments reduction and allowed decompression of intra-articular hematomas, removal or debridement of loose fragments and the possibility of treating cartilage lesions. Since 1987, only a few case series reporting encouraging outcomes with lower complication rate compared to open techniques were published. However, the reported indications and surgical techniques are relatively heterogeneous.

According to the first aspect, most of the patients in the present review had a displaced transverse pattern. In these fractures, the assessment of intra-articular anatomic reduction is relatively easy once the hematoma has been washed out. Subsequent fixation can be easily carried out through a minimally invasive approach. Other patterns such as comminuted fractures [21] or variable fracture pattern including displaced transverse fractures [20] present a greater challenge.

The second aspect of this review refers to the different surgical techniques used in each single series. El-Sayed et al. were the only ones describing a technique of arthroscopically assisted closed reduction and percutaneous screw fixation [22]. Conversely Turgut et al. described a fixation with two K-wires in a cross disposition and reinforced it with a circumferential metallic cerclage [18]. All the other authors applied personal variations of the Carpenter's technique [24]. It consisted in a figure-8 tension band over two screws technique, which provided the most rigid fixation and resistance to construct failure when compared to screws alone and modified tension band technique. Chiang et al. and Makino et al. used a figure-8 cerclage over two cannulated screws [16,19], while Tandogan et al. adopted a figure-0 cerclage over two cannulated screws in osteopenic patients [20]. Finally, Yanmis et al. described a technique of reduction and arthroscopically assisted circular external fixation in comminuted fractures [21]. These fractures cannot be treated with internal fixation as it happens for displaced transverse fractures and external fixator is an alternative to the traditional partial or total patellectomy.

Looking at the outcomes and complications some data emerge clearly from the present review. The functional results according to the Lysholm score and the satisfaction rate are very positive. The rate of early or mid-term clinical or imaging complications is low and when it is compared to those of open procedures the difference is statistically significant ($P < 0.001$) [16].

This review has some limitations. First, the sample sizes in the included studies are small and the methodologies are primarily case series. The only comparative study (with open techniques) was conducted by Chiang et al. [16]. The small population is obviously a bias, however it is the consequence of the strict indications and the fact that it's a new surgical approach. In addition, although several databases have been accessed with different combination of appropriate keywords, it is possible that some papers may not have been included in our search. Finally, although functional outcomes are promising and the rate of complications is low, the average reported follow-up was generally short (28.9 months). This is an important limitation for a technique focused on reducing the risk of non-anatomical reduction and late onset of osteoarthritis.

5. Conclusion

The most appropriate fracture pattern to be treated seems to be displaced transverse fracture. Accurate anatomic reduction of the fragments avoids the risk of late cartilage degeneration. Arthroscopically assisted minimally invasive techniques combine the advantage of reduced local morbidity and precise evaluation of fragment reduction. Outcomes are generally very encouraging and

the early and mid-term complication rate is very low. These encouraging results must be confirmed in larger series and with longer FU studies.

Disclosure of interest

SL is consultant for Tornier, Amplitude, Smith & Nephew.

ADM is consultant for Arthrex, Orthofix.

The other authors declare that they have no competing interest.

References

- [1] Weber MJ, Janecki CJ, McLeod P, Nelson CL, Thompson JA. Efficacy of various forms of fixation of transverse fractures of the patella. *J Bone Joint Surg Am* 1980;62:215–20.
- [2] Ashby ME, Shields CL, Karmy JR. Diagnosis of osteochondral fractures in acute traumatic patellar dislocations using air arthrography. *J Trauma* 1975;15:1032–3.
- [3] Hung LK, Chan KM, Chow YN, Leung PC. Fractured patella: operative treatment using the tension band principle. *Injury* 1985;16:343–7.
- [4] Muller ME, Schneider R, Willenegger H. Manual of internal fixation: techniques recommended by the AO Group. Berlin: Springer; 1979.
- [5] Bartončěk J, Rammelt S. Early history of operative treatment of patellar fractures. *Int Orthop* 2015;39:2303–8.
- [6] Kadar A, Sherman H, Drexler M, Katz E, Steinberg EL. Anchor suture fixation of distal pole fractures of patella: twenty-seven cases and comparison to partial patellectomy. *Int Orthop* 2016;40:149–54.
- [7] Yang L, Yueping O, Wen Y. Management of displaced comminuted patellar fracture with titanium cable cerclage. *Knee* 2010;17:283–6.
- [8] Gosal HS, Singh P, Field RE. Clinical experience of patellar fracture fixation using metal wire or non-absorbable polyester – a study of 37 cases. *Injury* 2001;32:129–35.
- [9] John J, Wagner WW, Kuiper JH. Tension band wiring of transverse fractures of patella. The effect of site of wire twists and orientation of stainless steel wire loop: a biomechanical investigation. *Int Orthop* 2007;31:703–7.
- [10] Luna-Pizarro D, Amato D, Arellano F, Hernández A, López-Rojas P. Comparison of a technique using a new percutaneous osteosynthesis device with conventional open surgery for displaced patella fractures in a randomized controlled trial. *J Orthop Trauma* 2006;20:529–35.
- [11] Perry CR, McCarthy JA, Kain CC, Pearson RL. Patellar fixation protected with a load-sharing cable: a mechanical and clinical study. *J Orthop Trauma* 1988;2:234–40.
- [12] Wu CC, Tai CL, Chen WJ. Patellar tension band wiring: a revised technique. *Arch Orthop Trauma Surg* 2001;121:12–6.
- [13] Papalia R, Osti L, Del Buono A, Denaro V, Maffulli N. Glenohumeral arthropathy following stabilization for recurrent instability. *Br Med Bull* 2010;96:75–92.
- [14] Del Sel G, Máspero G, Del Sel N, Russo L, Del Sel J. Arthroscopically assisted percutaneous screwing of patellar fractures. *OJSM* 2014;2 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4595874/>.
- [15] Chiang CC, Huang CK, Chen WM, Lin CF, Tzeng YH, Liu CL. Arthroscopically assisted percutaneous osteosynthesis of displaced transverse patellar fractures with figure-eight wiring through paired cannulated screws. *Arch Orthop Trauma Surg* 2011;131:949–54.
- [16] Chiang CC, Chen WM, Jeff Lin CF, Chen CF, Huang CK, Tzeng YH, et al. Comparison of a minimally invasive technique with open tension band wiring for displaced transverse patellar fractures. *J Chin Med Assoc* 2011;74(7):316–21.
- [17] Scholes C, Houghton ER, Lee M, Lustig S. Meniscal translation during knee flexion: what do we really know? *Knee Surg Sports Traumatol Arthrosc* 2015;23:32–40.
- [18] Turgut A, Günel I, Acar S, Seber S, Göktürk E. Arthroscopic-assisted percutaneous stabilization of patellar fractures. *Clin Orthop Relat Res* 2001;(389):57–61.
- [19] Makino A, Aponte-Tinco L, Muscolo DL, Puigdevall M, Costa-Paz M. Arthroscopic-assisted surgical technique for treating patella fractures. *Arthroscopy* 2002;18:671–5.
- [20] Tandogan RN, Demirors H, Tuncay CI, Cesur N, Hersekli M. Arthroscopic-assisted percutaneous screw fixation of select patellar fractures. *Arthroscopy* 2002;18:156–62.
- [21] Yanmis I, Oğuz E, Atesalp AS, Ozkan H, Kürklü M, Demiralp B, et al. Application of circular external fixator under arthroscopic control in comminuted patella fractures: technique and early results. *J Trauma* 2006;60:659–63.
- [22] El-Sayed AM, Ragab RK. Arthroscopic-assisted reduction and stabilization of transverse fractures of the patella. *Knee* 2009;16:54–7.
- [23] Sattler RW, Schikorski MM. Transverse patellar fracture – reposition and stabilization from its arthroscopic viewpoint. *Zentralbl Chir* 1987;112:1515–9.
- [24] Carpenter JE, Kasman RA, Patel N, Lee ML, Goldstein SA. Biomechanical evaluation of current patella fracture fixation techniques. *J Orthop Trauma* 1997;11:351–6.