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ORIGINAL PAPER

Patient-related outcomes after proximal tibial fractures

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Abstract

Purpose The purpose of the study was to assess patient-related outcomes at short-term follow-up in patients with a proximal tibial fracture.

Methods One hundred sixteen patients (119 fractures) treated at our institution during 2012 were retrospectively reviewed. Follow-up was 1.6 (SD ± 0.4) years post-injury, including the short musculoskeletal function assessment and visual analog scale for pain and satisfaction. Fractures were classified by the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association classification and divided in two groups: simple and complex.

Results Patients with simple fractures reported lower short musculoskeletal function assessment indices and less pain on visual analog scale than those with complex fractures. No difference was found in short musculoskeletal function assessment between surgically and non-surgically treated patients. Non-surgically treated patients reported less pain and were more satisfied. The overall complication rate was 30 (25%) of 119 fractures, with surgical treatment carrying a 7.0 (95% CI: 1.5–34) odds ratio for local complications.

Conclusions This study provides information about realistic prognosis after proximal tibial fractures. The finding that surgically treated patients had similar outcomes to non-surgically treated ones may indicate that surgery improves the prognosis of complex fractures to a level comparable to the prognosis of less severe ones. However, the risk of complications after surgery should guide treatment when surgery is not clearly indicated.

Keywords Proximal tibial fracture · Patient-related outcome · PRO · Short musculoskeletal function assessment · SMFA

Introduction

Fractures of the proximal tibia have a bimodal distribution pattern, including osteoporotic older women with low-energy trauma and younger men with high-energy trauma [1, 2]. They account for 2.2% of all fractures [3] and have a substantial socioeconomic impact as younger patients lose working days and older patients need assistance [4].

The range of fracture severity is wide, from simple non-displaced fractures to highly comminuted fractures with accompanying soft tissue injuries. Rasmussen et al. suggested surgical treatment in the presence of any medial or lateral instability of the extended knee joint [5]. Joint surface depression is another indication for surgery, though there is no universally accepted recommendation regarding the degree of displacement [6, 7]. Minimally displaced fractures could be successfully treated in a cast [8]. Consensus is lacking regarding the choice of cast or brace, the duration of external support, the use of passive motion, and weight-bearing recommendations [8–13].

Regarding surgery, a single-incision approach using lateral locked plates is feasible even in bicondylar fractures, with less blood loss and smaller wounds but possibly a higher risk of malalignment [14, 15]. Complication rates can be kept low also in dual-incision plating [16]. A circular external fixator may have benefits in reduced blood loss, shorter hospital stay, and fewer complications compared to open reduction and internal fixation [17].

Time to union varies and is usually between ten and 36 weeks [7, 8, 10, 11]. The risk of non-union is around 1.6% [11].

Little is known about patient-related outcome. It has been shown that older age corresponds to poorer outcomes in

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patients over 55 years of age, and that radiographic fracture severity corresponds to poorer outcomes [11, 18].

The aim of this study was to describe patient-related outcomes after proximal tibial fractures at a minimum of one year post-injury, stratifying by fracture type and treatment. Outcomes included patient satisfaction, pain, subjective function, and length of sick leave.

Materials and methods

Patient selection

The study was performed at two sites of Skåne University Hospital (the cities of Malmö and Lund). All patients 18 years or older and treated for a fracture of the proximal tibia in 2012 were identified from the hospital's administrative database, based on International Classification of Diseases − 10 coding. One hundred fifty-four fractures in 150 patients met these criteria. Patients treated elsewhere (eight), having incomplete medical records (two), or sustaining the fracture before 2012 (24) were excluded, leaving 119 fractures, in 116 patients.

Hospital charts

Information was obtained from hospital charts on method of external stabilization and its duration, weight-bearing recommendations, duration of sick leave, local complications (within 12 months), and general complications (within 3 months). Data on the patients' physical (including American Society of Anesthesiologists classification), psychological, and social status were registered (Table 1). Mechanism of injury, trauma severity (high/low energy), soft-tissue status (open/closed), and treatment were also registered.

Classification

Anterior-posterior, lateral, and two oblique views digital radiographs of the knee were performed in all patients and additional CT scans in the majority. All fractures were classified according to the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association classification with respect to type (A, B, or C) and group (1, 2, or 3) [19]. Fractures in group 41-B1 were further classified at sub-group level (41-B1.1-3). To provide groups of sufficient size for comparison, we categorized all fractures into two groups: a complex fracture group (41-B3, 41-C2, 41-C3) and a simple fracture group (all other).

Follow-up

A standardized questionnaire was sent to the patients at a mean 1.6 (SD ± 0.4) years post-injury. A visual analog scale, ranging from 0 to 100, was used to assess level of pain and satisfaction. The short musculoskeletal function assessment (SMFA) was used to assess functional status. The SMFA questionnaire contains a dysfunction index (34 items are grouped in four categories: daily activities, emotional status, function of the arm and hand, and mobility) and a bother index (12 items for assessment of how much patients are bothered by functional impairment). SMFA indices range from 0 to 100, with higher scores indicating less function/more bother [20].

At follow-up, eight patients were deceased (nine fractures) and 33 patients did not respond to the questionnaire. Due to difficulties in interpretation of patient-related outcome results for patients with bilateral fractures, these were excluded, leaving 73 fractures (61%) for analysis of patient-related outcome data.

Statistical analysis

Results are presented as medians, means, and proportions. The Student *t* test was used for comparing means of normally distributed data. The Mann-Whitney *U* test was used for comparing medians in data that were not normally distributed. The Chi^2 test was used for comparing proportions. Cox regression analysis was used for obtaining hazard ratios. Cohen's kappa test was used to determine level of variation. Results are given as medians or percentages with 95% confidence intervals (95% CI) unless otherwise stated. P values < 0.05 were considered statistically significant.

Results

Demographics

The mean age was 58 years (SD ± 18; range 18–95). Forty-eight fractures (40%) occurred in men. The distribution of fracture patterns according to the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association classification is given in Fig. 1. There were 61 simple and 58 complex fractures. Patient characteristics were comparable between the groups (Table 1). Data on substance abuse, including smoking, was lacking in the majority of cases, precluding further analysis. Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association classification did not differ between men and women. The proportion of women increased with increasing age: 27 of 29 fractures in those over 70 years occurred in women, compared to four of 15 under 40 years. In patients between 40 and 70 years age, 40 of 75 were women. All fractures were closed. Thirty percent of the fractures were caused by high-energy trauma, 60% by low-energy trauma, and 10% could not be determined. The proportion of high-energy trauma decreased with increasing age.

Table 1 Patient characteristics in 119 proximal tibial fractures

Patient characteristics	All fractures $n = 119$, n (%)		Simple fractures $n = 61$, n (%)		Complex fractures $n = 58$, n (%)	
Age, mean ± SD	58.2 ± 18.1		58.6 ± 17.6		57.7 ± 18.8	
Gender						
Men	48	(40%)	25	(41%)	23	(40%)
ASA[1]						
I	39	(33%)	20	(33%)	19	(33%)
II	48	(40%)	26	(43%)	22	(38%)
III	30	(25%)	13	(21%)	17	(29%)
IV	2	(2%)	2	(3%)	0	
Dementia/psychological disability						
Diagnosed	8	(7%)	5	(8%)	3	(5%)
Suspected	7	(6%)	4	(7%)	3	(5%)
None	103	(87%)	51	(84%)	52	(90%)
Information missing	1	(1%)	1	(2%)	0	
Smoking						
Yes	25	(21%)	10	(16%)	15	(26%)
No	48	(40%)	24	(39%)	24	(41%)
Information missing	46	(39%)	27	(44%)	19	(33%)
Alcohol/drugs						
Abuse	7	(6%)	4	(7%)	3	(5%)
Suspected abuse	2	(2%)	1	(2%)	1	(2%)
Normal	22	(19%)	10	(16%)	12	(21%)
Information missing	88	(74%)	46	(75%)	42	(72%)
Type of work						
Easy/medium physically demanding	39	(33%)	20	(33%)	19	(33%)
Very physically demanding	22	(18%)	12	(20%)	10	(17%)
Unemployed	3	(3%)	1	(2%)	2	(3%)
Retiree	51	(43%)	25	(41%)	26	(45%)
Missing	4	(3%)	3	(5%)	1	(2%)

[1] American Society of Anesthesiologists physical status classification system

Treatment

Sixty-eight (57%) of 119 fractures were treated surgically: 21 (34%, 95% CI: 23–48%) simple fractures and 47 (81%, 95% CI: 69–90%) complex fractures ($P < 0.001$). The median time from admission to surgery was two days (mean 2.7, range 0–9). Surgically treated patients were younger and had lower American Society of Anesthesiologists classification compared to non-surgically treated patients. Other patient characteristics (Table 1) did not differ between surgically and non-surgically treated patients. Plate and screw fixation was used in 54 (81%) of the 67 surgically treated fractures. Other implants used were screws, external fixators, pins, and biological implant.

Casting and bracing were the most frequently used external stabilization methods, both for surgically and non-surgically treated fractures. The choice of external stabilization did not differ between simple and complex fractures, types of treatment, weight-bearing recommendations, age groups, sex, American Society of Anesthesiologists class, or having another fracture, but differed between the two sites (Table 2). The duration of external stabilization did not differ between simple (6.5 weeks, 95% CI: 6–7) and complex (7 weeks, 95% CI: 6–9) fractures ($p = 0.15$). Non-surgically treated fractures were stabilized shorter compared to surgically treated fractures: 6 (95% CI: 6–7) vs. 8 (95% CI: 6–9) weeks ($P = 0.010$) and had shorter time to full-weight bearing: seven (95% CI: 6–8) vs. 10 (95% CI: 10–12) weeks ($P < 0.001$). Nine (8%) fractures were allowed immediate protected weight bearing.

Patient-reported outcomes

SMFA indices were lower, indicating better function, in simple fractures compared to complex fractures (Fig. 2). There

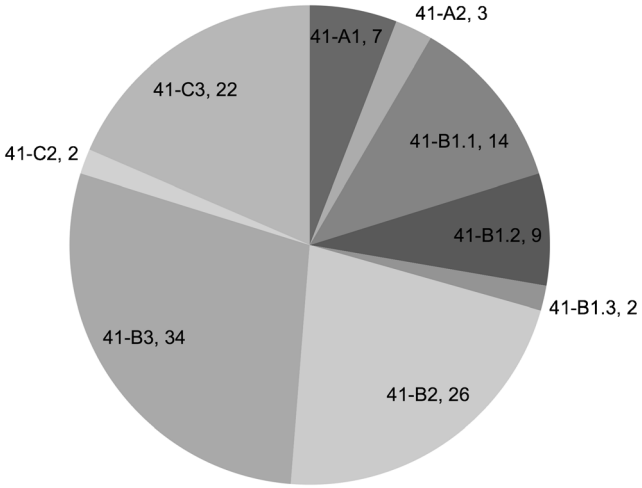

Fig. 1 Distribution of fracture patterns according to Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association classification in 119 fractures. B2, B3, and C3 fractures accounted for two thirds (69%) of all fractures

was no statistically significant difference between non-surgically and surgically treated fractures.

Five single SMFA questions were analyzed separately (Fig. 3). Patients with complex fractures had more trouble with recreational activities (mean difference: 0.53, 95% CI: 0.06–1.00, $P = 0.034$) and feeling disabled (mean difference: 0.95, 95% CI: 0.37–1.53, $P = 0.002$).

Seventy-three patients responded to a question regarding their mobility and walking ability compared to the time before injury. Overall 22 (30%) reported equal or better function. Fourteen (41%, 95% CI: 25–58%) of patients with simple fractures and seven (19%, 95% CI: 8–36%) of patients with complex fractures reported equal or better function ($P = 0.050$).

Seventy-four and 73 patients reported on the visual analog scale for pain and satisfaction, respectively. The median visual analog scale score was 20 for both pain and satisfaction. Median pain for simple fractures was 10 (95% CI: 1–22), compared to 31 (95% CI: 20–49) in complex fractures ($P = 0.004$). There was no significant difference in satisfaction between the groups ($P = 0.14$). Surgically treated patients had more pain: 29 (95% CI: 10–48) vs. 10 (95% CI 0–23) ($P = 0.024$) and were less satisfied: 27 (95% CI: 13–38) vs. 15 (95% CI 0–28) ($P = 0.014$).

Table 2 Type of external stabilization. The use of cast or brace differed between the two sites of the hospital ($P < 0.001$)

	Lund		Malmö	
Initial method	*n*	% (95% CI)	*n*	% (95% CI)
Cast	6	12 (5–25)	53[1]	76 (64–85)
Brace	38	78 (63–88)	8	8 (5–21)
Other[2]	5	10 (3–22)	9	9 (5–21)
Total	49		70	70

[1] Twenty (38%) of 53 initial casts were changed to a hinged brace during the early rehabilitation period

[2] "Other" includes external fixators, no external support, and six cases with missing information

Sick leave

Sixty-four (97%) of 66 working/job-seeking patients needed sick leave. Median time off work was 16 (range: 3–61) weeks. Patients with complex fractures had longer time off work: 21 (95% CI: 15–27) vs. 15 (95% CI: 12–18) weeks ($P = 0.011$). Patients with surgically treated fractures had longer time off work: 18 (95% CI: 16–25) vs. 14 (95% CI: 12–17) weeks ($P = 0.009$).

Complications

Thirty (25%) of 119 fractures had complications: 14 (12%) local, 12 (10%) general, and four (3%) both (Table 3). The crude ($P = 0.45$), general ($P = 0.52$), and local ($P = 0.25$) complication rate, respectively, did not differ between simple and complex fractures. In a Cox regression analysis including gender, age group, fracture type, surgical or non-surgical treatment, and high/low-energy trauma as variables, only surgical treatment was a significant risk factor for complications. Surgically treated fractures had hazard ratio 7.0 (95% CI: 1.5–34) for complications. The finding remains when both fracture type and data on high/low energy are omitted from the regression analysis. Neither fracture type nor high/low energy was a risk factor for complications when omitting treatment data from the analysis. Of 18 fractures affected by local complications, nine were re-operated upon within one year.

Discussion

The main finding of this study is that patients with radiographically more complex fractures have a more guarded prognosis concerning patient-related outcome and pain. Although surgically treated patients had more pain and were less satisfied, surgery was not associated with a worse SMFA index. Our patients reported similar SMFA indices at follow-up, compared to data from the Swedish Fracture Register (Fig. 2). Other studies have reported both better and poorer outcomes in terms of SMFA indices [18, 21]. Case mix, local setting (for example trauma centre studies), and field of interest (for example surgically treated cases only) introduce selection bias, which hampers comparisons between studies. This study comprises all types of proximal tibial fractures in all types of adult patients within a defined catchment area, resulting in an older cohort compared to other studies. These studies typically

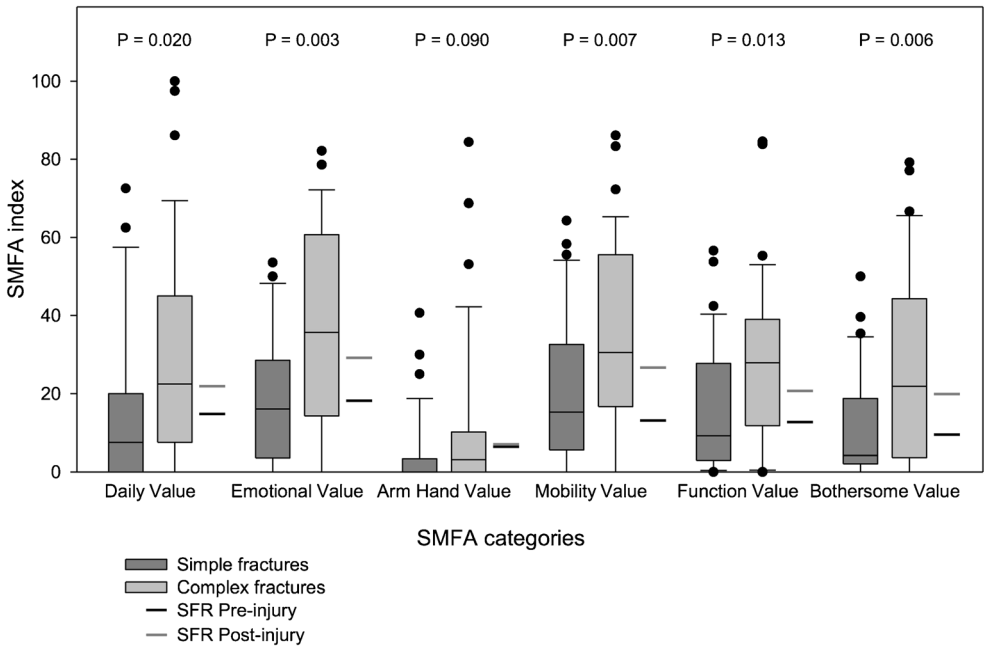

Fig. 2 SMFA indices at 1.6 years follow-up for simple and complex fractures. Box plots show the 10th, 25th, 50th (median), 75th, and 90th percentiles and outliers. *P* values are given from comparisons of simple vs. complex fractures. Data from the Swedish Fracture Register (SFR) (means pre-injury and at 1 year follow-up) are included for reference (personal communication)

report mean ages between 44 and 55 years [1, 2, 5, 11, 22], compared to 58 years in the present study. Like Jensen et al. [23], but in contrast to a large Scottish study [2], we found a slight overweight for females in the cohort.

Only 29% of the patients had unchanged or better mobility and walking ability at follow-up, which is comparable to patients with a hip fracture [24]. The high prevalence and long duration of sick leave also reflect the impact of proximal tibial fractures. Although loss of function to some extent was common, with difficulties jogging and bicycling etc., a majority reported retained basic functions, such as walking and working ability at follow-up. These findings can be used when informing patients about realistic goals during recovery.

In plate and screw fixation, we have used 4.5 mm anatomically pre-shaped implants with the option of locking screw fixation laterally, often supplemented with a 3.5-mm medial plate in bicondylar fractures. One retrospective study reported a higher risk of implant extraction due to local discomfort with 4.5 mm implants compared to 3.5 mm implants [25]. However, the rate of implant extraction in that series was much higher than in the present study, and the authors did not detect a difference in patient-reported outcomes when comparing 4.5 to 3.5 mm implants.

It is encouraging that no differences in SMFA indices were found between surgically and non-surgically treated patients. We believe this reflects that surgery improves the prognosis for complex fractures to a level comparable to simpler fractures. However, the selection of fitter and younger patients for surgery inevitably introduces a selection bias with this retrospective study design.

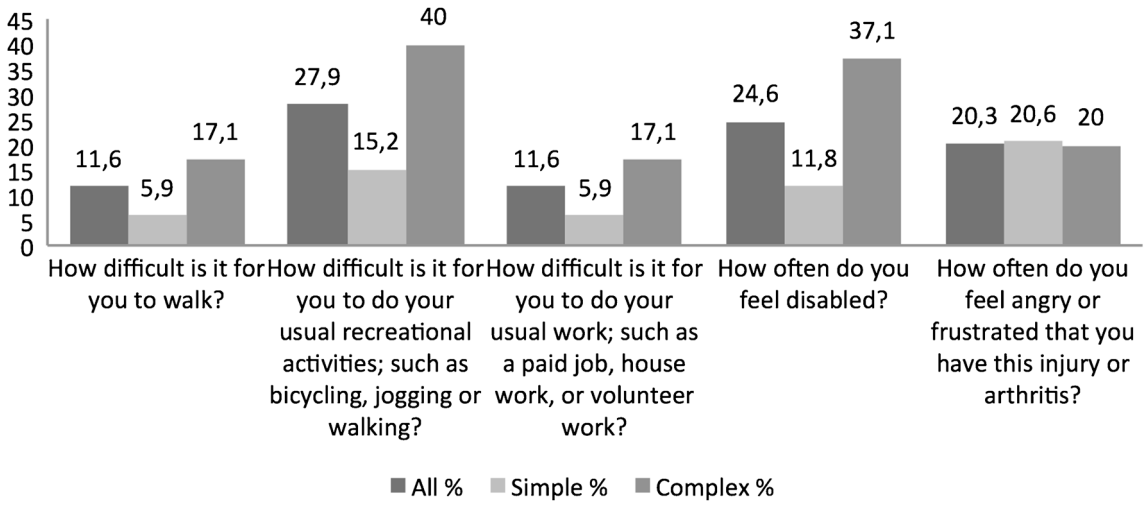

Fig. 3 The proportion of patients who answered "very/often" to five selected questions from the SMFA

Table 3 Local and general complications in 119 fractures

Complications	Any $n = 119$, n (%)		Surgical $n = 67$, n (%)		Non-surgical $n = 52$, n (%)	
Superficial infection	2	(2%)	2	(3%)	0	
Deep infection	4	(3%)	4	(6%)	0	
Haemorrhage/rupture	2	(2%)	2	(3%)	0	
Delayed union	4	(3%)	4	(6%)	0	
Other [1]	11	(9%)	9	(13%)	2	(4%)
Total	23	(19%)	21	(31%)	2	(4%)
Thrombosis	6	(5%)	3	(4%)	3	(6%)
Pulmonary embolus	4	(3%)	3	(4%)	1	(2%)
Myocardial infarction	1	(1%)	1	(1%)	0	
Pneumonia	7	(6%)	2	(3%)	5	(10%)
GI-bleeding/ulcer	1	(1%)	0		1	(2%)
Total	19	(16%)	9	(13%)	10	(19%)

[1] Other complications include suspected compartment syndrome, discomfort from implant material, seroma, and impaired knee flexion, all leading to secondary surgery. There was also osteoarthritis in combination with calcium phosphate leakage from bone void filler, impaired range of motion, instability in two fractures, depressed articular surface, foot pain due to nerve injury, and peroneal palsy

We are aware of no previously published study on visual analog scale satisfaction after proximal tibial fracture treatment. This instrument is continuously used in Swedish hip arthroplasty patients and in some hip fracture studies. As a crude comparison, the patients in this study were slightly more satisfied than hip fracture patients, who report a mean visual analog scale value of 28 [24]. On the other hand, they were less satisfied than hip arthroplasty patients, reporting a mean of 15 [26].

The use of cast or brace varied substantially between the two sites of our department, reflecting the lack of evidence. A well-conducted study comparing the two methods with regard to secondary displacement, range-of-motion, time off work, and patient-related outcomes is warranted.

The incidence of deep infection in this study (3.4%) was low compared to other studies [11, 14, 16], perhaps reflecting the fact that there were no open fractures and that our policy is to wait until soft tissue swelling resolves in high-energy injuries of the knee.

Strengths and limitations of the study

Due to the retrospective nature of this study, we cannot make recommendations on choice of treatment. Rather, the aim was to provide knowledge on patient-reported outcomes in the first years after the fracture. On the other hand, we present a consecutive, unselected cohort with a fair rate of follow-up.

The time to follow-up was sufficient for detecting early complications, but not to detect secondary osteoarthritis which is a major concern after proximal tibial fractures [5, 11, 27–29]. One of the main indications for surgery is to restore more normal joint biomechanics, aiming to decrease the risk of post-traumatic osteoarthritis. Assessment of the quality of articular reduction, alignment, and meniscal status, all of which are important factors for outcome, was not made. A future follow-up of this cohort could give additional knowledge about the possible prognostic value of pain and short-term outcome with regard to osteoarthritis development.

Non-surgically treated patients were allowed to bear full-weight earlier. However, we have no data on the true extent of weight bearing in our cohort. Devices for measurement of foot-sole pressure exist and should ideally be used in prospective studies, as patients often have difficulties with compliance to partial weight-bearing recommendations [30].

How to best determine fracture severity is debatable. Radiographic fracture classification may be the easiest way (i.e., "simple and complex" in our study). The amount of trauma energy is an important variable, but delimitation is arbitrary. Grouping based on surgery or not adds the treating physicians' compound considerations on patients' general health and functional demands, i.e., severe fractures in individuals with contraindications for surgery are treated non-surgically. These limitations led us to report on all three types of grouping.

Conclusions

This study provides information about realistic short-term prognosis after simple and complex proximal tibial fractures. We found surgery to be the main independent risk factor for complications, which should be borne in mind when considering treatment options for fractures at "border-line" for surgical or non-surgical management.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study was approved by the Regional Ethical Review Board.

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