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# Evaluating clinical and radiological results following surgical treatment of patella fractures

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**Abstract**
The aim of treating patella fractures is to restore the integrity of the extensor mechanism. Various treatment methods applied include fastening techniques with different wires, fastening with screws, a combined tension band method and screw technique, segmental patellectomy, a combined tension band method and segmental patellectomy technique, and total patellectomy. Fifty-two patients underwent surgery for isolated closed patella fractures between 2002 and 2012 at the Department of Orthopaedics and Traumatology. Of these 52 patients, 23 patients who completed their follow-up were clinically, radiologically, and retrospectively evaluated. Of the 23 patients, 13 (57%) were male and 10 (43%) were female. The functional status was regarded as excellent in 16 (70%) patients, good in six (26%), and unsatisfactory in one (4%) post-surgery. Radiological evaluation of the patients showed that there was type 1 PFA in five (22%) patients, type 2 PFA in five (22%), type 3 PFA in eight (35%), and type 4 PFA in five (22%). The degree of union was radiologically evaluated in all patients during the follow-ups. Implant irritation, implant migration, and fractures were the most frequently observed complications.

**Keywords:** Bostrom classification, Iwano evaluation scale, modified tension band method, patellofemoral arthrosis, patella fractures

## Introduction

The patella is the biggest sesamoid bone in the body. Due to its location, it completes the extensor mechanism of the knee joint. Patella fractures are frequently observed around the age of 40. They constitute approximately 1% of skeletal system injuries [1]. Patella fractures may occur due to direct trauma or indirectly from the pulling force of the quadriceps and patellar tendon. The aim of treating patella fractures is to restore the integrity of the extensor mechanism. Opinions differ on the approach for surgical treatments. Various treatment methods applied include fastening techniques with different wires, fastening with screws, a combined tension band method and screw technique, segmental patellectomy, a combined tension band method and segmental patellectomy technique, and total patellectomy. The anterior tension band technique used by Pauwel in 1950s for the treatment of the patella fractures was accepted and developed by the Arbeitsgemeinschaft für Osteosyntesefragen (AO) group [2].

The purpose of this study is to evaluate the clinical and radiological results following surgery using the modified anterior band method to treat isolated closed patella fractures after at least a 2-year follow-up period.

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## Material and Methods

Fifty-two patients underwent surgery for isolated closed patella fractures between 2002 and 2012 at the Department of Orthopaedics and Traumatology . Ethical protocol number of the research is 2014-232. Of these 52 patients, 23 patients who completed their follow-up were clinically, radiologically, and retrospectively evaluated.

Patients who had surgery for same-side femur and/or tibia fractures together with their patella fracture were excluded from the evaluation. Patients who had ligament injury in the ipsilateral knee to the patella fracture and were not included in a rehabilitation program were also excluded from this study. Furthermore, patients in whom wound site infections developed post-surgery and patients who had head trauma or history of pregnancy were excluded as well.

For all patients who were evaluated in the emergency department and whose physical examinations were completed, an anteroposterior (AP) and lateral knee radiograph was taken and classifications were made according to AO [2]. Following this, the

affected leg was put in a long leg splint to keep the knee in full extension.

The average time period between injury and surgery was 2 (1–6 ± 1.4) days. The average hospitalization period was 3.6 (3–8 ± 1.2) days.

**Surgery Technique**

Of the 23 patients, 10 were operated under general anesthesia, 12 under spinal anesthesia, and the remaining 1 under epidural block anesthesia.

Two K-wires were run in a distal to proximal direction to reduce the bone fragments anatomically. The wires were sent from the third closed to the knee joint. This was done in three equal pieces in the sagittal plane of the patella, as parallel as possible. Cerclage wires (loop 18 G) were passed from the bonding place of the quadriceps tendon as far as possible, from the bottom of the K-wires going out and passed from the front face of the patella using the tension ban method (Zuggurtung method) in a figure-of-eight configuration. Applying the cannula screw in the tension band method, two pieces of 4.5 mm cannula screws were sent from the third part closed to the knee joint. This was done in three equal pieces in the sagittal plane of the patella, as parallel as possible. Cerclage wires (loop 18G) were passed from the inside of the cannula screws and passed from the front face of the patella in a figure-of-eight configuration.

**Follow-up Protocol**

With stable fracture fastening provided during surgery, patients in splints were mobilized by crutches. Segmental load was given at a tolerable rate starting from day two post-surgery. Follow-ups were conducted at 1 month, 2 months, 3 months, 6 months, 12 months, and 24 months post-surgery.

After radiological confirmation of union and clinical determination of reduced effusion in the knee, absence of wound site problems, passive joint movement width >90 degrees, tolerable pain, progression toward normal quadriceps power within 18–24 months on average, progressively active exercises were commenced in the patients. Quadricep power was evaluated by measuring the femoral diameter in each patient.

Patients were clinically and radiologically evaluated against controls. While evaluation of the degree of union was conducted using AP and auxiliary radiographs, functional evaluation of tangential patella radiographs was conducted using the Bostman scoring form [3] (table 1). Evaluation of the degree of PFA was performed using the Iwano evaluation scale [4] (Figure 1).

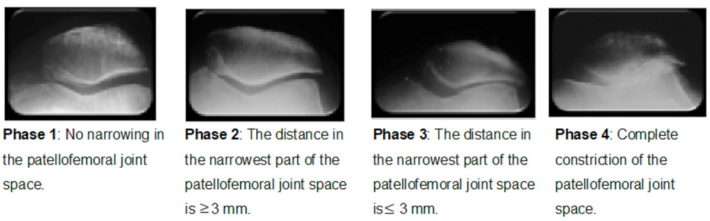


**Figure 1.** Classification of patellofemoral joint arthrosis (Iwano evaluation scale)

**Table 1.** Bostman Scoring Form

| | |
|---|---|
| **A) MOVEMENT WIDTH (ROM)** | |
| a) Full extension, ROM > 120° | 6 |
| b) Full extension, ROM 90–120° | 3 |
| c) Loss of full extension, ROM < 90° | 0 |
| **B) PAIN** | |
| a) None or minimal on exertion | 6 |
| b) Moderate on exertion | 3 |
| c) In daily activity | 0 |
| **C) WORK** | |
| a) Original job | 4 |
| b) Different job | 2 |
| c) Unable to work | 0 |
| **D) ATROPHY** | |
| a) <12 mm | 4 |
| b) 12–25 mm. | 2 |
| c) >25 mm | 0 |
| **E) SUPPORT USAGE** | |
| a) None | 4 |
| b) Assistance required sometimes | 2 |
| c) Assistance required always | 0 |
| **F) EFFUSION** | |
| a) None | 2 |
| b) Reported to be present | 1 |
| c) Present | 0 |
| **G) KNEE GIVING WAY** | |
| a) None | 2 |
| b) Sometimes | 1 |
| c) In daily life | 0 |
| **H) GOING UP AND DOWN THE STAIRS** | |
| a) Normal | 2 |
| b) Difficult | 1 |
| c) Disabling | 0 |

The results were reported as follows: 28–30 points as excellent, 20–27 points as good, and <20 points as unsatisfactory.

**Statistical Evaluation**

All values including means, standard deviations, frequencies, and percentages were derived from descriptive statistics. The relationship between the fracture types and functional results and between degree of PFA and functional results were evaluated using both Kruskal Wallis and Spearman Correlation analyses. A p-value ≤0.05 was determined as statistically significant. Statistical analysis was done using the SPSS (Statistical Package for Social Sciences for Windows 18.0) software program.

**Results**

A total of 23 patients who completed their follow-ups, including 13 (57%) males and 10 (43%) females, were evaluated.

The average age of all patients included in the study was 48.4±15.3 (21–70) years. For all male patients, the average age was 47.2±17.4 (23 to 70 years). The average age for female patients was 49.9±14.3

(21 to 66 years) in the females. We observed that patella fractures occurred earlier (20 to 45 years) in male patients and later (45 to 70 years) in female patients.

Following evaluation of the fractures in accordance with the AO classification, 5 (22%) fractures were determined to be extra-articular (34-A1) and 18 (88%) fractures were intra-articular. 13 (57%) of the patients were operated due to left patella fractures, and 10 (43%) of the patients were operated due to right patella fractures. The average follow-up duration was 48.2±12.3 (25 to 124) months. The length of time between injury and surgery was an average of 2 (1-6 ± 1.4) days. Average hospitalization period was 3.6 (3-8±1.2) days.

In 17 patients, the modified anterior tension band method was applied. Modified tension combined with peripheral wiring was applied in two patients. Fastening with screws was used in two patients. Peripheral wiring was used in another two patients.

Functional results were obtained from all patients. Results were determined to be excellent in 16 (70%) patients, good in 6 (26%) patients, and unsatisfactory (4%) in one patient. In the patient with unsatisfactory results, there was a delay in rehabilitation because of a cerebrovascular event (CVE) post-surgery. Knee extension was >120 degrees in 21 patients and between 90 and 100 degrees in two of them. No patient experienced full loss of knee extension.

Following radiological evaluation of the patients, it was observed that all fractures achieved full union. The degree of PFA was also evaluated. Type 1 PFA was observed in 5 (21%) patients, type 2 in 5 (22%) patients, type 3 in 8 (37%) patients, and type 4 in the remaining 5 (21%) patients.

Of the 23 fractures, 18 were intra-articular and five were extra-articular. There was no statistically significant relationship between the functional results of the patients post-surgery and the fracture type (intra-articular or extra-articular) ($p=0.651$).

After examining the effect of patella fracture type on the development of PFA, it was determined that PFA severity increased as the complexity of the fractures increased. This relationship was statistically significant ($p\leq0.05$).

The degree of PFA was evaluated. It was determined that five patients were in phase 1, five patients were in phase 2, eight patients were in phase 3, and five patients were in phase four. It was observed that the degree of PFA did not affect the functional status of the patients ($p\leq0.515$).

**Discussion**

The primary goals in the treatment of the patella fractures are to provide anatomical reduction, mobilize the patient early, prevent the development of joint stiffness, and provide the best functional results possible.

Treatment of patella fractures may be done conservatively or surgically. While conservative methods have been shown to be effective in non-displaced patella fractures, surgery should be the first treatment option in displaced patella fractures [5].

The role of the patella in knee function is a major talking point in the treatment of patella fractures. Some authors suggest that the patella may not be necessary for knee function, and it could be excised, if fractured. Others maintain that the patella has an important place in knee function, and claim that it should be protected [6].

Although there is a consensus on the indications for surgical treatment in patella fractures, the rationale for selecting the surgical method of choice remains variable. Surgical methods are preferred in open patella fractures, patella fractures with retinaculum tear, patella fractures with displacement greater than 3 mm, and patella fractures with articular incongruity greater than 2 mm [5].

Yesiller et al compared Magnuson's technique with the Mini External Fixator (MEF), the AO stretching band, and the modified AO stretching band techniques in a biomechanical study performed using five cadaveric knees. They determined that fixation with MEF provided the most stability, followed by the AO stretching band technique [7].

Burvant et al compared the modified tension band technique with the modified tension band technique with screws. They determined that the modified tension band with screws technique performed significantly better than did the modified tension band [8].

Of a total of 42 patients, Cakici et al applied fastening with the modified anterior tension band technique in 34 cases, fastening with the peripheral cerclage method in three cases, butterfly fixation fastening in two cases, fastening with the indirect reduction method in two cases and fastening with the external fixator in one case. Of the 34 cases in which the modified anterior tension band method was applied, results obtained were determined as excellent in 26 cases, good in six cases, and unsatisfactory in two cases [9].

Sim et al applied a combined modified tension band with cerclage method to a total of 22 patients including 16 with transverse patella fractures and six multi-part patella fractures. The results obtained were determined as excellent in 20 patients and good in two patients. It was thought that good stability positively impacted functional levels [10].

In their study of 27 patients, Esenkaya et al utilized central transverse in 12 cases, subpolar "apical" in nine cases and segmental fracture fastening in six cases. They performed osteosynthesis including Magnuson's technique for two patients (7.4%), standard tension band for 8 (29.6%) patients, and modified AO tension band method for 17 (63%) patients. The results observed in the last control of the cases were determined as excellent in 15 (55.6%) cases, good in 8 (29.6%) cases, and unsatisfactory in 4 (14.8%) cases, as determined by the Levack scoring system [11]. Of the four patients with unsatisfactory results, three of them had additional fractures in other bones. The fourth patient had a reoccurrence of the fracture because of a fall and underwent another surgery. Atrophic changes were observed radiologically in 8 (29.6%) cases, and required medication in some of the cases.

The initial fracture type has been considered as the most important factor affecting functional results post-surgery. It has been suggested that functional results obtained in transverse fractures were better than those obtained in segmental fractures. Saltzman

et al showed that initial fracture type was the sole factor that affected their results [12]. In segmental fractures, poor fastening and rehabilitation insufficiency have been cited in literature as common reasons for failure.

Of the 23 cases in our study, there were 18 intra-articular and five segmental fractures. Following evaluation by Bostman scoring, results obtained from our study were determined as excellent in 14 (76%) patients, good in 4 (19%) patients, and unsatisfactory in 1 (5%) patient. Although our sample size was smaller, fracture type did not statistically influence functional results. In the single patient with poor functional level in our study, we suspect that a combination of the patient's age and immobilization following a cerebrovascular event may have been contributed to this unsatisfactory result.

Of the ten patients treated by the peripheral cerclage wire method, Dimiski et al obtained results determined as good in three patients and unsatisfactory in two patients [13]. They suggested that the high percentage of unsatisfactory results using the peripheral cerclage wire method was due to poor fixation.

Yang et al operated on 21 patients with multi-part patella fractures. They applied the tension band method using titanium cables. They determined the functional levels to be excellent in 17 patients and good in four patients. They attributed their successful results to the early commencement of exercises in the post-surgical period [14].

In our study, the cerclage method was applied in two patients, with excellent result in one and good in the other. Both fractures were intra-articular in nature. One of the fractures was a segmental fracture. Although this method did not provide optimum stability, we believe that early movement and appropriate rehabilitation had a positive effect on the results.

Yavarikia et al applied diagnostic arthroscopy to 22 patients with transverse patella fractures. Surgeries were conducted using the modified tension band method. A normal patellofemoral cartilage finding was observed in five patients. Phase I chondral lesions were observed in 10 patients, phase II chondral lesions in four patients, and phase III chondral lesions in three patients. There was no statistically significant relationship between the functional level of the patients and the radiologic findings observed [15].

Tukenmez et al operated on 50 patients with patella fractures including 27 segmental (satellite) fractures, 13 transverse fractures, 8 distal pole fractures, 1 chondral fracture, and one longitudinal fracture. Of the 50 cases, osteosynthesis with modified AO tension band technique was applied in 25 (50%) cases, osteosynthesis with screw, and Kirschner wires was applied in 10 (20%) cases, segmental patellectomy was used in 6 (12%) cases, tension band combination was used in 8 (16%) cases, and arthroscopic manipulation was applied in 1 (2%) case. Results obtained from this study were determined as unsatisfactory in 13 (26%) cases, good in 21 (42%) cases, and excellent in 16 (32%) cases [16]. Additional pathologies in three patients and an open fracture in another patient may have contributed to the number of unsatisfactory results obtained. Degeneration of the patellofemoral joint was observed in only four patients.

In our study, the degree of patellofemoral arthrosis was determined as type 1 in 5 patients, type 2 in 5 patients, type 3 in 8 patients, and type 4 in 5 patients. Although the fracture type negatively affected the degree of PFA, we determined that the degree of PFA did not have a negative effect on the functional level observed in the patients. We think the most important reason here that lending assistance of the surgery method applied in feeding the cartilage and forming the joint surface by allowing to the early movement and in protecting the knee movement width with the early rehabilitation.

Karim et al operated on 18 patients with transverse closed isolated patella fractures. Surgeries were performed using the modified tension band method. The following complications were observed: superficial infection in three patients, wire migration in two patients, wire fracture in three patients, and displacement greater than 2 mm in one patient [17]. Following antibiotic treatment, infections observed were resolved. Additional surgical intervention was not necessary for any of the observed complications. An extension constraint of 25 degrees was observed in patients whose displacement was ≥ 2 mm.

In our study, there were no occurrences of union delay or failure of union among our patients. Implant irritation occurred in eight patients. of these 8 patients, the implants had to be removed from four of them.

Wire migration was observed in three patients, and wire rupture occurred in two patients. The implants in these 5 patients had to be removed, as they caused pain and extension constraint during movements of the knee joint.

## Conclusion

In conclusion, we evaluated clinical and radiological results following surgical treatment of patella fractures using peripheral wiring, modified anterior tension band, and cannula screw methods. Our results in the medium term are good. We also observed that fracture type did not affect the clinical results, although it was positively correlated with the degree of PFA. However, we believe that the degree of PFA does not affect the functional results of the patients. Finally, we believe that early commencement of knee joint rehabilitation exercises post-surgery is an important factor in achieving good clinical results.

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**Ethical approval**
*Ethical approval: This article contains studies with human participants and This article does not contain any studies or animal participant performed by any of the authors.*

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