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Management and Outcome of Elderly Patients With Patellar Fracture Treated With Novel Modified Cerclage Wiring

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Abstract

Introduction: The purpose of this study is to assess the efficacy and security of a fixation method for fixing patellar fractures in elderly patients utilizing modified cerclage wire. **Methods:** From January 2015 to December 2020, 31 cases (age≥65 years old) of closed patellar fracture were treated by modified cerclage wiring. Patients in these instances ranged in age from 65 to 87 (73.7 ± 7.2 years), with 15 men and 16 women. 4 instances were type 34-C1 (transverse fracture) according to the AO/OTA classification, 27 cases (87%) were comminuted fractures, including 11 cases that were type 34-C2 (3 fragments), and 16 cases that were type 34-C3 (more than 3 fragments). Postoperative problems such as fragment re-displacement, nonunion, internal fixation loosening, infection, and internal fixation rupture were evaluated. The clinical grading systems of Böstman were used to assess the postoperative clinical outcomes. **Results:** Thirty one patients in all were monitored for 14 to 31 months (22.2 ± 4.5 months). After the procedure, the fracture took 2.5-3.5 months (2.92 ± .25 months) to heal. There were no postoperative issues like infection, dislocation, implant breakage, uncomfortable hardware, or post-traumatic osteoarthritis. According to the clinical grading scales of Böstman, the average score of the final follow-up was 28.6 ± 1.1 (range 26-30). 29 (94%) of the patients had excellent results, whereas just 2 (6%) had good results. The patient's knee flexion activity ranged from 110 to 140°, making for a favorable prognosis. **Conclusion:** Most patella fractures in the elderly are comminuted. Elderly patients with patellar fractures may be successfully treated with modified cerclage wire, with good results and no noticeable side effects.

Keywords

patellar fracture, elderly patients, cerclage wiring, open reduction and internal fixation, novel technique

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Introduction

The biggest sesamoid bone and a crucial component of the extensor mechanism is the patella.[1] Patella fracture is a common problem, representing approximately 1% of all fractures.[2] Due to the anatomical characteristics, most patellar fractures are intra-articular fractures, and the most frequent injury to the extensor mechanism of the knee is a broken patella.[2] Patella fractures that cause a disruption in the extensor mechanism or are displaced have often been surgically repaired in the past. The surgical procedure was

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performed so that the extensor mechanism could work again, the patella's articular surface could be repaired, and the knee's original functionality could be regained.[2,3] It became more common to treat patellar fractures with open reduction and internal fixation, and many fixation techniques were used to treat the patellar fractures. However, the function of knee joint will be poor if the internal fixation fails, and osteoporosis is one of the factors for the failure of internal fixation.[4,5] A little issue in an old patient might set off a chain reaction that results in death.[6] How to fix patellar fractures rigidly and achieve excellent function in the elderly is a challenge to clinical orthopedic surgeons.[7] This research aimed to demonstrate the usefulness of a unique approach to treating patellar fractures in the elderly.

Materials and Methods

All patellar fracture patients seen at our facility between January 2015 and December 2020 were included in a retrospective analysis. The following criteria were established by us: The following criteria were met: (1) age ≥65 years, (2) closed fracture, (3) no other injuries of the ipsilateral lower extremity, (4) no previous surgical history of the ipsilateral lower extremity, (5) injured knee exhibited no obvious dysfunction prior to fracture, (6) treated by modified cerclage wiring, and (7) follow-up time at least 1 year.

We collected the following data for each patient who met the inclusion criteria: gender, age, injury mechanism, fracture type, other site injuries, medical diseases, time from injury to operation, and days of hospital stay. Complications after the operation were also collected and analyzed.

Several classifications exist for patellar fractures. We used the AO/OTA classification to classify the bony injury.[8] During the most recent follow-up appointment, the surgical outcomes were assessed using the clinical grading scales of Böstman, which include measures of mobility, discomfort, productivity, atrophy, assistance with work, effusion, weakness, and collapse. Less than 20 points were poor, 20-27 points were good, and 28-30 points were excellent.[9]

Surgical Procedures

A tourniquet was used in conjunction with either general or spinal anesthesia to put the patient to sleep prior to surgery. After making a longitudinal, midline incision in each patient's knee and releasing the superficial fascia, we first looked for and diagnosed any damage to the patient's extensor mechanism. Then, the fractures of the patella were exposed and reduced with reduction forceps. Temporary K-wires were utilized to stabilize the fracture after reduction, and a C-arm fluoroscopic image was taken to evaluate the joint surface. Patellar fractures were treated using a cutting-edge method after the articular surface had been smoothed. Figure 1 shows a diagram of the steps involved. The upper half of the patella was sutured with a steel wire, and a piece of steel was set aside in front of the patella. A second steel wire was then sutured across the thighbone's lower half; a third steel piece was set aside for use in the patella's anterior region. Using the third steel wire, we made a figure-of-eight design to pierce the reserved steel wire in front of the patella. The first and second steel wires were tightened simultaneously, then, the third wire was also tightened. The articular surface was reevaluated with the use of the C-arm fluoroscopic image. The patellar fracture fixation is considered to be stiff if the fracture fragments remain attached to one another even when the knee is bent at an angle of more than 90°. The rare steel wires was cut and bent to avoid irritation of the soft tissue.

Postoperative Management

Plaster casts were not used in any of the patients throughout the post-operative period to assist in the

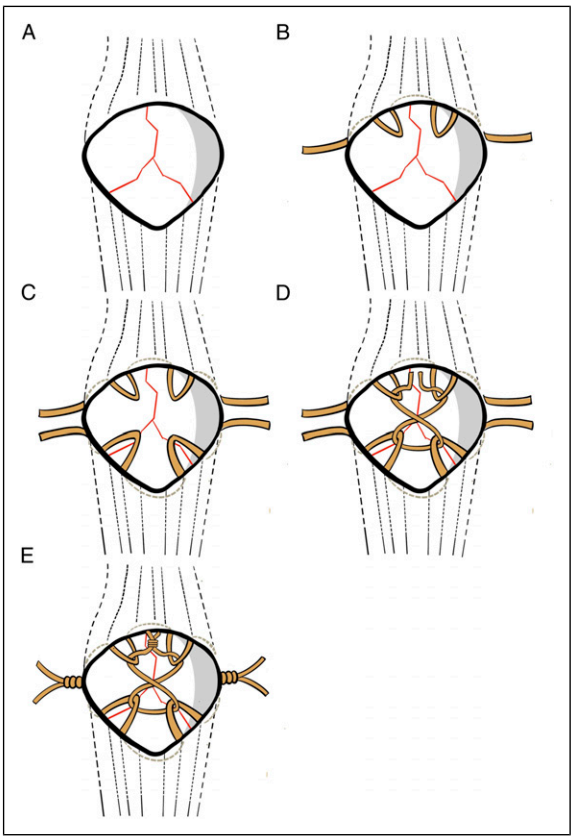

Figure 1. Illustrations of patellar fixation techniques using modified cerclage wiring fixation.

stabilization of the knee joint. On the first day following surgery, functional activities such as quadriceps-femur contraction exercises and usage of the CPM were carried out. Patients were also permitted to begin partial weight-bearing immediately after surgery, with full weight-bearing being permitted after 4 weeks had passed since surgery. After the procedure, an X-ray was taken 1 month, 2 months, 3 months, 6 months, and 12 months afterward. The function of the knee joint was assessed using the clinical grading systems developed by Böstman during the most recent follow-up examination (Figures 2 and 3).

Results

Over a period of 6 years, from January 2015 to December 2020, our institution treated a total of 302 patients with patellar fractures. Out of these, 31 patients met the inclusion criteria for our study. There were 15 males and 16 females, average age of 73.7 ± 7.2 years old (range 65-87 years), with 12 right and 19 left patellar fractures. All patients had patellar fractures caused by falling on the same plane. One patient had an ipsilateral humeral fracture. Out of the total number of patients, 35% (eleven individuals) did not have any pre-existing health conditions. The remaining patients had a medical history that included hypertension (11 patients), ischemic cardiac disease (6 patients), and diabetes (6 patients). The average duration between the injury and the operation was 4.35 days, with a range of 1 to 10 days. Based on the AO/OTA classification, the fracture types were as follows: 4 cases were classified as type 34-C1 (transverse fracture), and 87% (27 cases) were comminuted fractures, with 11 cases classified as type 34-C2 (3 fragments) and 16 cases classified as type 34-C3 (more than 3 fragments).

Twenty nine patients performed spinal anesthesia, and 2 patients performed general anesthesia. Only one patient developed lower extremity venous thrombosis during treatment. The average duration of follow-up was 22.2 ± 4.5 months, with a range of 14-31 months. No complications, such as infection, bone re-displacement, loosening or breakage of internal fixation, or nonunion, were observed during the follow-up period. The fracture healing

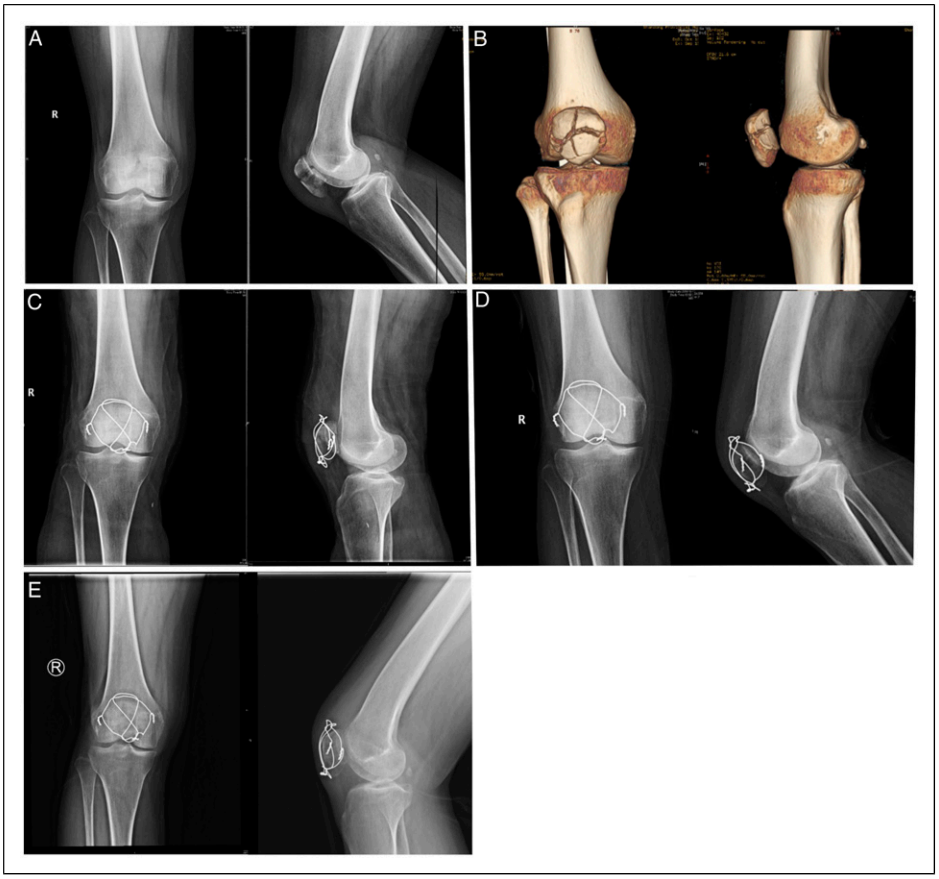

Figure 2. A 68-year-old male with a patellar fracture. (A) X-ray before surgery. (B) CT before surgery. (C) Post-fixation with modified cerclage wiring. (D and E) 3 months and 12 months after surgery.

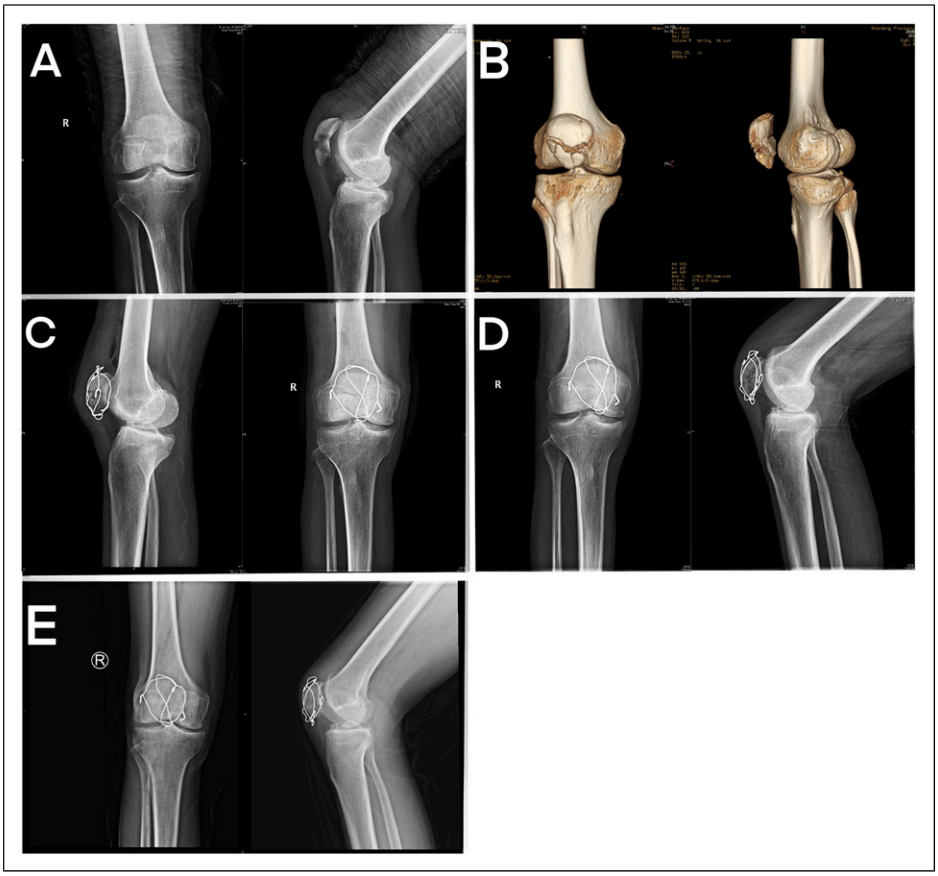

Figure 3. A 66-year-old male with a patellar fracture. (A) X-ray before surgery. (B) CT before surgery. (C) Post-fixation with modified cerclage wiring. (D and E) 3 months and 12 months after surgery.

time ranged from 2.5-3.5 months, with an average of 2.92 ± 0.25 months from the date of surgery.

According to Böstman's clinical grading scales, the average score at the final follow-up was 28.6 ± 1.1 (with a range of 26-30). A total of 29 patients (94%) achieved excellent outcomes, while 2 patients (6%) achieved good outcomes. The patients displayed a range of knee flexion activity of 130° (with a range of 110-140), and the prognosis was deemed satisfactory.

Discussion

A patella fracture is a prevalent injury in clinical practice, comprising roughly 1% of all fractures. This fracture typically occurs in young patients and can result from direct or indirect force.[1,3,9] In younger patients, transverse fractures are a commonly observed type due to the inherent strength of their bones and the active contraction of the quadriceps tendon.[9,10] The features of patellar fractures in elderly individuals differ from those in younger patients due to the presence of weakened bones. Shabat S conducted a retrospective study of 68 patellar fractures in elder adults over 65 years of age and found that 82% had a simple fall and 66% of the fracture types were comminuted fractures.[6] We got similar results in this study, all patients were due to simple falls, and 83% were comminuted fractures. Because the elderly are often accompanied by osteoporosis, a minor force can lead to fractures. Meanwhile, due to the reaction and muscle strength of the elderly are poor, the elder patients are often too late to respond when the falling, direct force on the patella results in comminuted fractures.[2]

Most scholars have reached a consensus on the treatment of the patellar fracture. Patients with disrupted extensor mechanism or fracture displacement greater than 2 mm should undergo operative treatment.[2,11,12] The objectives of operative treatment are 2-fold: first, to repair the damaged articular surface and the knee extension mechanism, and second, to ensure strong fixation to enable prompt initiation of functional exercises.[12-14] Numerous techniques have been employed in the treatment of patellar fractures, such as the tension band construct using wires or cannulated screws, basket plates, lag screws, anterior mesh plates, and cerclage wiring, among others.[2,3,12,15,16]

Despite surgical treatment increases the rate of the union of fracture, decreasing the rate of malunion, and promoting functional recovery, implant failure is also common, and outcomes remain unsatisfactory. A meta-analysis of 24 studies was conducted, and the results showed that the re-operation was 33.6%, which was predominantly due to the complication of hardware.[17]

Previously, the treatment of choice was tension band fixation.[18-20] Two parallel K-wires inserted across the fracture in a longitudinal orientation were the most common method of fracture fixation, sometimes accompanied with anterior tension bands arranged in a figure 8 formation. When the knee is bent, the tensile forces are reduced and the compression forces are increased at the articular surface.[21] Nevertheless, in a biomechanical study conducted by Zderic et al, it was shown that there was a significant variation in interfragmentary pressures during knee flexion, and that the articular surface tended to gap during simulated knee extension.[22] Additionally, this technique is not without complications. Lin did a prospective, randomized, controlled trial and found the hardware complication after tension band fixation was 50%, the complication included re-displaced fragments, painful hardware, and tension band loosening or migration.[15] Up to 60% of patients undergoing tension band fixation would have problematic implants necessitating removal, according to a study by Howatt J et al.[3]

Matthews B. et al believed that the osteopenic bone of elderly patients lacks the strength to support tension band fixation and results in fixation failure prior to the bone union.[2] Miller MA et al demonstrated that older patient age is a strong predictor of fixation failure, due to the weakened bone with advancing age.[4] Smith ST found that older patients were more likely to have early failure after a patellar fracture.[5] In addition, Miller MA et al found comminuted fracture was an independent factor of failure of fixation with the usage of K-wires.[4] Unfortunately, advanced age, comminuted fractures are 2 characteristics of the elderly, it is a challenge even for experienced surgeons. Therefore, an effective method of fracture fixation in elder patients with patellar fractures need to be explored.

It is generally accepted that the peripatellar soft tissues were responsible for a significant portion of the patella's stability; hence, it is just as vital to repair the peripatellar soft tissues as it is to reduce and stabilize the patella fracture. In accordance with this principle, the method of cerclage wiring fixation could achieve this goal because of its peripatellar circumferential wire loop design. Then, Matsuo T et al reported 1 patient with a patellar fracture who was treated by cerclage wire fixation got intact knee extension function even with the fracture nonunion.[23] Hambright DS also reported that at postoperative follow-up visits, 2 patients were found to have bone nonunion; nevertheless, neither patient required revision surgery for the nonunion, and both maintained satisfactory range of motion with full extension.[20] Because of its circumferential nature, cerclage wire fixing has also been employed for a long time to treat comminuted patella fractures. However, this technique also has many disadvantages, such as the fixation is not rigid and the plaster cast is necessary, and re-displacement of bone due to loosening and breaking of steel wire. Because of these drawbacks, it is often used in conjunction with other methods of fixation. High rates of functional range of motion, bone union, and low rates of fixation failure were found in a research that used a combination of cerclage wire fixation and numerous tension bands. Lue et al used a nickel-titanium patellar concentrator combined with non-absorbable suture cerclage to treat the comminuted fracture and the rate of excellent and good outcomes was 100%.[24]

To treat patellar fractures in the elderly, we adapted a cerclage wire fixation. The surrounding ligaments are decreased indirectly while the steel wire is sutured in place. Compression fractures result from the transfer of tension around the patella into pressure between the fracture pieces. When the knee is bent, the tension is released and the tensile forces are transformed into compressive forces at the articular surface by the third steel wire arranged in a figure-of-eight pattern in front of the patella. This design also provides a stronger and more stable fixation effect than the patients who were fixed by cerclage wiring fixation without the third steel wire. The design also allows patients to begin early knee joint functional exercises, which is critical for preventing joint stiffness, which is a common side effect of patellar fracture therapy. Overall, 94% (29/31) of patients who had outstanding results and 6% (2/31) of patients who had good results were happy with their outcomes in our cohort research. In our study, the early exercises played an important role to get satisfactory results after the operation. Due to the usage of K-wires, another advantage of this method was to avoid the complication caused by K-wires, which include pain, K-wires out, and so on. This technology also requires lower cost compared with other methods which were used to treat patellar fractures.

There are several tips about this method to avoid failure. Firstly, tighten steel wires evenly to avoid overtightening or loosening, in addition, tightening unevenly may cause displacement of the fracture. Secondly, the free bone fragments were reduced indirectly, therefore, the repairment of the patellar surface ligaments and surrounding patellar ligaments was vital to maintain the reduction of comminuted fractures. Thirdly, for some comminuted fractures, smoothness of the articular surface is primary, and the anatomic reduction of another site should not be pursued too much.

There are still a number of caveats to this research. Due to the study's retrospective nature, its small sample size,

the absence of a control group, and the necessity for further investigations with a bigger sample size and prospective designs, firmer conclusions cannot be drawn.

Conclusion

Patellar fracture in elderly patients are always comminuted fractures. Patellar fractures in the elderly respond well to a unique approach of stabilization including modified cerclage wire. This fixation is rigid enough to allow patients to perform early exercises and could achieve satisfactory outcomes.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

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Trial Registration

ChiCTR2200061618. Registered 22 May 2022. Retrospectively registered. Trial registry: Chinese Clinical Trial Registry.

Statement of Ethics

The experimental protocol was established according to the ethical guidelines of the Helsinki Declaration and approved by the Human Ethics Committee of Shandong Provincial Hospital Affiliated to Shandong First Medical University. Written informed consent was obtained from all study participants.

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