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Does closer placement of cerclage wire enhance functional outcomes in tension band wiring of patellar fractures?

Да ли ближе постављање серклажне жице побољшава функционалне резултате фиксације прелома пателе тензионом жичаном траком?

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Да ли ближе постављање серклажне жице побољшава функционалне резултате фиксације прелома пателе тензионом жичаном траком?

SUMMARY

Introduction/Objective Patellar fractures are commonly treated with tension band wiring (TBW). The distance between the cerclage wire and the superior pole of the patella is crucial for surgical outcomes. This study evaluates the impact of this distance on clinical and functional results.

Methods A retrospective cohort study of 64 patients with transverse patellar fractures treated with TBW was conducted. Patients were categorized based on the distance of the cerclage wire from the bone: < 4 mm, 4–8.5 mm, and >8.5 mm. Clinical outcomes included bone union, implant failure, and wound complications. Functional outcomes were assessed using range of motion (ROM) and modified Hospital for Special Surgery (HSS) knee scores.

Results Significant differences were observed in outcomes depending on wire placement. Patients with cerclage wires < 4 mm from the bone exhibited poorer functional results, with a mean modified HSS Knee Score of 70 ± 9.2 and an average ROM of 103.6 ± 42.4 degrees. Patients with wires positioned 4–8.5 mm from the bone demonstrated better functional recovery, achieving higher knee scores and greater ROM. Statistical analysis confirmed that closer wire placement negatively affected clinical outcomes ($p < 0.05$).

Conclusion This study suggests that positioning cerclage wires too close to the bone (< 4 mm) may impair functional outcomes despite presumed mechanical stability. An optimal distance of 4–8.5 mm balances mechanical stability and soft tissue protection, offering improved clinical and functional results. These findings challenge conventional surgical approaches, emphasizing the importance of precise wire positioning in TBW procedures.

Keywords: patellar fractures; tension band wiring; cerclage wire; clinical outcomes; functional outcomes; surgical techniques

САЖЕТАК

Увод/ЦиљПреломи пателе се најчешће фиксирају техником тензионе жичане траке (*TBW*). Растојање између серклажне жице и горњег пола пателе сматра се пресудним за хируршки исход. Циљ студије био је да процени утицај овог растојања на клиничке и функционалне резултате.

Методе Спроведена је ретроспективна кохортна студија која је обухватила 64 болесника с попречним преломом пателе леченим *TBW*-ом. Болесници су подељени у три групе према удаљености серклажне жице од кости: < 4 *mm*, 4–8,5 *mm* и > 8,5 *mm*. Клинички исходи су обухватили срастање кости, отказ импланта и компликације ране, док су функционални исходи оцењивани опсегом покрета (*ROM*) и модификованим *Hospital for Special Surgery* (*HSS*) оценама за колено.

Резултати Исходи су значајно варирали у зависности од положаја жице. Болесници код којих је серклажна жица била постављена < 4 *mm* од кости постигли су слабије функционалне резултате (средња модификована *HSS* оцена 70 ± 9,2; просечан *ROM* 103,6 ± 42,4). Најбоље опоравак забележен је код болесника са жицом удаљеном 4–8,5 *mm*, који су остварили више оцене колена и већи *ROM*. Статистичка анализа потврдила је да ближе постављање жице негативно утиче на клиничке исходе ($p < 0,05$).

Закључак Постављање серклажне жице сувише близу кости (< 4 *mm*) може да наруши функционалне резултате упркос очекиваној механичкој стабилности. Оптимално растојање од 4–8,5 *mm* обезбеђује бољу равнотежу између механичке стабилности и заштите меког ткива, што доводи до побољшаних клиничких и функционалних исхода. Ови налази доводе у питање конвенционалне хируршке приступе и наглашавају значај прецизног позиционирања жице у *TBW* процедури.

Кључне речи: преломи пателе; тензиона жичана трака; серклажна жица; клинички исходи; функционални исходи; хируршке технике

INTRODUCTION

Fractures of the patella pose a challenge to orthopedic trauma management because of the important role of the patella in the extensor mechanism of the knee. The treatment of patellar transverse fractures has traditionally been done with tension band wiring (TBW) for restoration of the articular surface and early mobilization [1, 2]. However, it is also noted that there are

methodologically more updated approaches and meta-analysis findings which should be incorporated to have a better perspective on TBW outcomes and biomechanics. [3, 4]. The configuration of cerclage wire in TBW, especially its distance from the bone, is important in deciding the biomechanical stability of the fixation and therefore clinical results. Early mobilization and a good biomechanical fixation will improve the pain and the quality of life [5].

Among the biomechanical properties, stability given by cerclage wire is an important area of concern for TBW that can influence both bone union rates and the incidence of postoperative complications [6, 7]. The proximity of the cerclage wire to the bone has specific implications on the biomechanics of the fixation [3]. For instance, Zhang et al. demonstrated that TBW with cerclage wire positioned near the bone surface significantly reduces micromotion at the fracture site, facilitating bone healing [8, 9]. Conversely, an increased distance between the cerclage wire and the bone may lead to suboptimal compression and stability, raising the risk of implant failure and delayed union [10]. This observation underscores the need for exquisite surgical practice and indicates that further specific endeavors in informing these effects are needed [3].

Further, poor positioning of the wire has been associated with increased postoperative complications, including migration of the wire and soft-tissue irritation [11]. Though these problems have been described in prior research, more elaborate investigation and comparison with existing literature would be helpful for the purpose of further understanding of the optimal positioning and its effects [3].

There is a gap in the literature regarding the proximity of the cerclage wire to the bone, and the safe distance in patellar fractures treated with tension band wiring remains underexplored. Therefore, the aim of our study was to calculate the effect of the distance of the cerclage wire to the bone on clinical and functional outcomes and determine the safe distance in patients with transverse patellar fractures treated with TBW. This will reduce the margin of error in surgical technique and provide a touchstone for the clinician regarding the distance of the cerclage wire during surgery.

METHODS

Study design and population

This is a retrospective cohort study of a total of 108 patients between the ages of 18 and 65 years, suffering from C1 and C2 transverse patellar fractures, classified according to AO classification, who had undergone TBW with two Kirschner wires. The patients were treated

between January 2015 and December 2022 at a single tertiary care center. The exclusion criteria were multiple trauma patients, multiple fractures of the same limb, systemic, metabolic, and infectious diseases, application of cerclage to tension band wiring, use of cannulated screw and periprosthetic and pre-existing pathological conditions of the knee. Such criteria are aimed at providing homogeneous groups of patients, thus excluding factors that could enfluence results. All participants provided written informed consent prior to inclusion in the study. The study protocol was approved by the Institutional Ethics Committee of Harran University (Approval No: HRU-24/11/35) and conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments or comparable ethical principles.

Surgical technique

All surgeries were performed under general anesthesia. A standard, midline knee incision with medial parapatellar arthrotomy was made to gain access to the site of fracture. The skin incision was deepened, and the fractures were reduced using reduction clamps and confirmed under fluoroscopy. From the superior pole of the patella, two K-wires were introduced distally. Cerclage wire was passed around these K-wires and then tightened for compression of the fracture fragments. The tips of the proximal end were cut, and the K-wires were then bent and fixed. The surgical experience along with the frequency of performing this technique were recorded; whether these influences upon surgical outcomes should be noted. The knee was immobilized using an immobilizer for two weeks postoperatively to facilitate initial healing.

Postoperative care and follow-up

Patients began static isometric quadriceps strengthening exercises on the first postoperative day. Two weeks later, the range of motion (ROM) exercises started under the physiotherapist. The follow-up period included evaluations at 1, 3-, 6-, 12-, and 24-months post-operation. Clinical assessments included wound healing, level of pain, and functional recovery. Radiographic evaluations were performed at each visit to assess both the union condition of the fracture and the integrity of fixation.

Data collection

The main outcome measurements were the distance of the wire from the bone, measured directly from the lateral post-operative radiograph (Figure 1). For taking distance measurements, a consistent system was used to ensure that they are exact. To ascertain the measurements validity, tests for inter-observer and intra-observer reliability were done. The following outcomes were evaluated: clinical outcome and functional outcome, incidence of wound complications, union rates, and clinical follow-up. The patients' medical records and radiographs were critically reviewed to provide a logical explanation for the findings. Added to this, the range of motion (ROM) and functional outcomes were assessed at the last follow-up using the Modified Hospital for Special Surgery (HSS) Knee scores [12]. The properties and application techniques of the cerclage wires used were detailed, including material composition and tensioning method.

Statistical analysis

Data were analyzed using SPSS version 28.0. Descriptive statistics were summarized to provide information related to participant demographics and clinical characteristics. Frequencies, means, and standard deviations were computed for age, distance between the cerclage wire and bone, values of knee ROM, and Modified HSS Knee scores. Data were tested for normality using the Shapiro-Wilk test. For normally distributed data, Student's t-test was used, while Mann-Whitney U tests were employed for non-normally distributed data. Additionally, ROC curve analysis was applied to determine the threshold value of the distance of the cerclage wire that best predicts the patient's outcome. Identifying a specific point that maximizes the sensitivity and specificity of the cerclage wire distance as a measure of prediction for clinical and functional outcomes is essential. Chi-square tests were used to compare categorical data regarding the presence or absence of wound complications and implant failures, with statistical significance set at a p-value of 0.05.

RESULTS

This study is a retrospective cohort of 64 patients who had undergone tension-band wiring for transverse fractures of the patella. The following means and ranges were derived from the demographic profile: mean age (years) = 44.8 ± 17.1 (18-65 years) and mean follow-up period =

15.2 ± 5.4 months (Range = 9-24 months). The gender distribution comprised 35 male patients (54.7%) and 29 female patients (45.3%) (Table 1).

The mean distance between the cerclage wire and the superior pole of the patella was 6.3 ± 4.03 mm. The value of the distance had a wide range from 1 mm to 20.4 mm. Clinical outcomes showed nonunion in 2 cases (3.1%) wherein partial patelectomy was done. Site complications occurred in 3 cases (4.7%) of wound sites, and implant failures were noted in ten cases (15.6%) (Table 1).

We observed K-wire migration in one patient (1.6%). The cerclage wire displaced over the K-wire was seen in seven patients (10.9%). Also, wire breakage was seen in two patients (3.1%).

To assess clinical and functional outcomes prediction by cerclage wire distance, ROC curve analysis was employed. The area under the curve (AUC) value of 0.91 suggests that it is highly predictive of patient's prognosis. This study also showed that distance has high sensitivity and specificity for predicting implant failure (Fig. 2).

Mean Modified HSS Knee Scores for different cerclage wire distance categories were plotted to visualize the effect of wire distance on functional outcomes (Figure 3). The highest mean score was observed in the 4-8.5 mm category, indicating better functional outcomes.

The effects of the distance between the bone and the cerclage wire on knee range of motion (ROM) were investigated. The knee ROM is illustrated in Figure 3 for different distances of the cerclage wire. The data show that there is a relationship between knee ROM and the distance from the cerclage wire to the bone. Patients who have less than 4 mm difference had an average knee ROM of 108.6 degrees. Averagely, patients at a distance ranging from 4-8.5 mm exhibited the highest average knee ROM with a mean value being equal to 126.6 degrees, however; for those patients who were located more than 8.5 mm away, their average knee ROM was only measured as 80.6 degrees. These results are indicative that there is significant influence of cerclage wire's distance from the bone on its ability to aid in determining range of motion for knees. While putting it closer to bone (< 4mm) or keeping it around middle region (4-8.5 mm) will increase flexibility at this joint [11], furthering it away beyond 8.5mm decreases movement in this direction. These findings are essential in finding out what would be considered as an ideal cerclage wire to bone gap.

Patients with a distance between the cerclage and the superior pole of the patella less than 8.5 were divided into two groups: group 1 and group 2. Age against union rates, implant failures, and wound site problems were analyzed, showing there was no significant relationship to

patient outcome. Among patients who did experience nonunion, 2 of them (100% from the total of nonunion cases, 3.1% from the total of cases) also suffered from implant failures. Of the three patients with wound complications, two of them (66.7%) suffered implant failures (3.1% of cases) (Table 2).

The mean arc of motion for the knees was 103.6 ± 22.4°, ranging from 60° to 150°. The arc of motion was significantly different in the patients with cerclage wire distance less than 8.5 mm when compared in two groups (P = 0.001) (Figure 3). The mean Modified HSS Knee Score was 71.7 ± 9.2, and individual scores ranged from 45 to 100. The Modified HSS Knee Score was significantly reduced in the distance cerclage wire > 8.5 mm (P = 0.001) (Şekil 2). Subgroup analysis further within group 1, including patients whose cerclage wire distances were above 4 mm but less than 8.5 mm, showed that the former subgroup of patients had significantly lower clinical scores and ROM when compared to the latter subgroup at 4 mm and below (p = 0.03; 0.04 respectively) (Table 3).

DISCUSSION

Our study aimed to see the outcome in relation to the distance which separates the cerclage wire from the bone with respect to clinical and functional outcome in patients being treated for patellar fracture by using tension band wiring (TBW). With wires in cerclage, we assumed that if nearer to the bone, a better functional outcome would be produced, rather than farther away from the bone, in the usual assumption of the orthopedic surgical practice that assumes closer proximity gives better functional outcomes because it increases the mechanical stability of the bone, hence it would provide a better result.

In our results, the complications and clinical results we observed regarding the use of cerclage wires are parallel to similar studies in the literature. In the study conducted by Zhai et al. it was reported that all patella fractures treated with percutaneous cerclage wire in geriatric patients healed and there were no serious complications such as infection or wire migration. In this study, one case of wire breakage was reported after six months [13]. Yan et al. In another study conducted by et al., combined patella fractures were treated with a separate vertical wire method supported by a cerclage wire. According to the study results, no complications such as loss of reduction, implant breakage, nonunion or skin irritation were observed during an average follow-up period of 18.9 months [14]. Li et al. In this study, patellar fractures treated with modified cerclage wire in elderly patients were evaluated. During a mean follow-up period of 22.2

months, fracture healing was achieved in all patients and no significant postoperative complications were reported [15]. Monaco et al. In the study conducted by et al., patellar fractures treated using suture tape and metallic cerclage wire were compared. The study reported no significant differences in reoperation rates, fracture healing rates, and functional outcomes between the two methods [16].

Our findings demonstrate that cerclage wire has been used as an efficacious technique in patellar fractures management and despite the presence of complications in some instances; it generally gives good clinical results. These research, reviewed here, support the efficacy and security of cerclage wire in treating patella factures.

Our findings reveal the influence of the distance between cerclage wire and bone on knee range of motion (ROM) and functional outcomes. Modified HSS Knee Scores per average for different distance categories were plotted, where in the 4-8.5 mm distance category there was a high average score. This is indicative of better functional outcomes. Therefore, we evaluated the effects of different distances between Cerclage wire to bone on knee ROM as well as if these are related. According to Yan et al., when using separate vertical wire method assisted by a cerclage wire, which is situated at an optimal length from the bone, it has been reported that these patients demonstrate 131.3° average knee ROM [14]. Kumar and Kumar found that patients' knees ranged in angle from those with anterior cerclage wire insertion to reach up to 125.4 degrees [17]. Ninety-two percent of the patients involved in Kachare et al.'s study had attained active flexion of 90 degrees after one week following cerclage wiring together with figure-of-eight tension band technique [18]. It clearly showed better functional results with correct placement of cerclage wires at an appropriate distance from each other [18].

Our results demonstrate the effect of the distance between cerclage wire and bone on knee range of motion (ROM), and functional results. Average Modified HSS Knee Scores for different distances from cerclage wires were plotted and the 4-8.5 mm group had the highest average score. It shows better functional results. Zhai et al., reported that percutaneous cerclage wire was an effective treatment in elderly patients with fractured patella, where all fractures healed successfully [13]. Mahajan et al., indicated that stable fixation was achieved with low nonunion rates when Cerclage wire was used in combination [19]. Meng et al., found that there were satisfactory clinical outcomes and low complication rates in a study by et al. using modified cerclage wire [20]. Raja et al.'s study demonstrated clinical improvement as well as reduced complications with cerclage wire application [21]. These findings suggest that correct use of cerclage wire improves knee range of motion and functional outcomes.

The study found that clinical outcomes and knee range of motion were better in patients with a cerclage wire distance less than 8.5 mm. Modified tension band wire for cerclage was recorded to cause reduced postoperative complications by Yu et al [22]. Harna and colleagues published their findings related to non-union patellar fractures managed surgically which demonstrated the same range of motion [23]. This is supported by Kachare et al's earlier study indicating that low complication rates and rapid recovery are provided through cerclage or figure-eight configuration [18]. This therefore substantiates the claim that accurate placement of the cerclage wire distance can aid in improving clinical outcomes. Consequently, according to Xiang et al., those treated with absorbable cannulated screws and high-strength sutures experienced lesser displacement as well as improved clinical results [7]. Such findings have shown that positioning is crucial for cerclage wire distance in managing patella fractures which if done accurately can improve overall treatment success.

The study, however, has some limitations: the wide age range in the sample of participants, 18-65 years, may introduce variability in bone quality and healing capacity that might influence the outcomes independent of the surgical technique used. It is further out of our control that the study is retrospective, so limiting us in controlling all the probable confounders that would affect the results.

Another limitation of this study includes the fractures, which are divided into types according to the AO classification and therefore could, in a way, falsify the results obtained by this form for more complex or different types of patellar fractures [24]. Some patients further had a full period of immobilization up to four weeks, especially those who ended up having implant failure. This theoretically could then affect the knee range of motion and functional recovery of the knee, confounding the effects attributed to cerclage wire distance.

In order not to fall into these limits and better validate our results, these could be prospective studies with a stronger design and the age within a less wide interval. Further histological analyses in future studies may, however, unveil further mechanisms that underlie our observations when studying the biological impact of cerclage wire proximity to surrounding soft tissues. In general, our study puts into perspective one of the rather understudied aspects of patellar fracture treatment. In so doing, we fill this gap and therefore add, in an aggregate manner, to more-refined knowledge of TBW techniques that will help in developing better surgical outcomes and more-refined protocols for the treatment of patella fractures.

CONCLUSION

This study assessed the effect of cerclage wire proximity to the bone in tension band wiring for patellar fractures. Contrary to common traditional belief, it was found that wires placed very close to the bone (4 mm and below) resulted in poorer outcomes. This has important implications for wire placement: Mechanical stability must be weighed against tissue integrity, specifically avoiding adverse effects on the quadriceps muscle. These findings challenge existing surgical dogma and suggest that further research is needed to refine surgical guidelines that balance both biomechanical and biological considerations for the ultimate benefit of patient outcomes.

Conflicts of interest: None declared.

REFERENCES

1. Melvin JS, Mehta S. Patellar fractures in adults. J Am Acad Orthop Surg. 2011;19(4):198–207. [DOI: 10.5435/00124635-201104000-00004] [PMID: 21464213]
2. Chloros GD, Kotsarinis G, Christou CD, Giannoudis PV. What's new in the management of patella fractures? Injury. 2022;53(6):1730–6. [DOI: 10.1016/j.injury.2022.03.035] [PMID: 35643733]
3. Zderic I, Stoffel K, Sommer C, Höntzsch D, Gueorguiev B. Biomechanical evaluation of the tension-band wiring principle: a comparison between two different techniques for transverse patella fracture fixation. Injury. 2017;48(8):1749–57. [DOI: 10.1016/j.injury.2017.05.037] [PMID: 28622833]
4. Gao Y, Wu G, Zhu H, Bian K, Wu D, Wei H. Dual tension band technique for patellar fractures involving articular surface and inferior pole: a retrospective cohort study and finite element analysis. Front Bioeng Biotechnol. 2025;13:1530745. [DOI: 10.3389/fbioe.2025.1530745] [PMID: 40104771]
5. Jurišić-Škevin A, Grbović V, Stanković I, Radunović A, Nurković J, Milošević B, et al. The impact of pain on functionality and health-related quality of life in patients with knee osteoarthritis. Srp Arh Celok Lek. 2019;147(1–2):45–51. [DOI: 10.2298/SARH171020009J]
6. Ho TYG, Lee Syn Yuk M. Fixation of patella fracture with non-metallic implant. J Orthop Trauma Rehabil. 2023;31(1):104–10. [DOI: 10.1177/22104917231197234]
7. Xiang F, Xiao Y, Li D, Ma W, Chen Y, Yang Y. Tension band high-strength suture combined with absorbable cannulated screws for treating transverse patellar fractures: finite element analysis and clinical study. Front Bioeng Biotechnol. 2024;12:1340482. [DOI: 10.3389/fbioe.2024.1340482] [PMID: 38515618]
8. Zhang ZS, Li PF, Zhou F, Tian Y, Ji HQ, Guo Y, et al. Comparison of a novel tension band and patellotibial tubercle cerclage in the treatment of comminuted fractures of the inferior pole of the patella. Orthop Surg. 2020;12(1):224–32. [DOI: 10.1111/os.12616] [PMID: 31958886]
9. Chang SM, Ji XL. Open reduction and internal fixation of displaced patella inferior pole fractures with anterior tension band wiring through cannulated screws. J Orthop Trauma. 2011;25(6):366–70. [DOI: 10.1097/BOT.0b013e3181dd8f15] [PMID: 21577073]
10. Kakazu R, Archdeacon MT. Surgical management of patellar fractures. Orthop Clin North Am. 2016;47(1):77–83. [DOI: 10.1016/j.ocl.2015.08.010] [PMID: 26614923]
11. Oh HK, Choo SK, Kim JW, Lee M. Internal fixation of displaced inferior pole of the patella fractures using vertical wiring augmented with Krachow suturing. Injury. 2015;46(12):2512–15. [DOI: 10.1016/j.injury.2015.09.026] [PMID: 26482481]
12. Evanich CJ, Tkach TK, von Glinski S, Camargo MP, Hofmann AA. Six- to ten-year experience using countersunk metal-backed patellas. J Arthroplasty. 1997;12(2):149–54. [DOI: 10.1016/S0883-5403(97)90060-7] [PMID: 9139096]
13. Zhai Q, Yang J, Zhuang J, Gao R, Chen M. Percutaneous cerclage wiring for type 34-C patella fracture in geriatric patients. Injury. 2020;51(6):1436–42. [DOI: 10.1016/j.injury.2020.03.040] [PMID: 32291087]
14. Yan SG, Li D, Cui Y, Hua X, Hemmann P, Schmidutz F. Management of comminuted inferior patellar pole fractures with cerclage-wire-augmented separate vertical wiring: a retrospective clinical study. Arch Orthop Trauma Surg. 2023;143(1):247–54. [DOI: 10.1007/s00402-021-04034-4] [PMID: 34232348]
15. Li L, Zhang Q, Tao F, Wang D, Dong J, Zhou D, et al. Management and outcome of elderly patients with patellar fracture treated with novel modified cerclage wiring. Geriatr Orthop Surg Rehabil. 2023;14:21514593231177983. [DOI: 10.1177/21514593231177983] [PMID: 37250018]
16. Monaco E, Saithna A, Cardarelli S, Bruni G, Carrozzo A, Annibaldi A, et al. No difference in clinical and radiological outcomes following fixation of transverse patella fractures with either suture tape or metallic cerclage: a retrospective comparative study. Orthop Traumatol Surg Res. 2021;107(8):103053. [DOI: 10.1016/j.otsr.2021.103053] [PMID: 34530129]
17. Kumar P, Kumar M. Fracture patella: fixation with cancellous screws and anterior cerclage wiring. Int J Orthop Sci. 2021;7(1):618–22. [DOI: 10.22271/ORTHO.2021.V7.I1N.2586]
18. Kachare A, Jagiasi J, Jadhav P, Munde K. Achieving rapid healing and low complication rates in patellar fracture fixation: the benefits of cerclage and figure-of-eight configuration. Cureus. 2023;15(5):e39059. [DOI: 10.7759/cureus.39059] [PMID: 37323351]

19. Mahajan A, Rathi M, Mahajan R, Kumar A, Saini M. Management of non-union patella fractures with modified tension band wiring and supplementary cerclage: a case series. J Clin Orthop Trauma. 2021;17:50–6. [DOI: 10.1016/j.jcot.2021.06.004] [PMID: 37065521]

20. Meng D, Xu P, Shen D, Chen Y, Zhu C, Hou C, et al. A clinical comparison study of three different methods for treatment of transverse patellar fractures. J Orthop Sci. 2019;24(1):142–6. [DOI: 10.1016/j.jos.2018.08.026] [PMID: 30316657]

21. Raja BS, Jain A, Paul S, Choudhury AK, Kalia RB. Plate osteosynthesis in patellar fractures: a systematic review and meta-analysis. Eur J Orthop Surg Traumatol. 2022;32(8):1627–40. [DOI: 10.1007/s00590-021-03143-5] [PMID: 34664117]

22. Yu T, Wu Z, Mohamed SO, Ju W, Liu X, Qi B. Modified tension band wiring of patellar fracture as a technique to minimize postoperative complications. Medicine (Baltimore). 2020;99(11):e19576. [DOI: 10.1097/MD.0000000000019576] [PMID: 32195969]

23. Harna B, Gupta P, Singh J, Rousa S, Gupta A. Surgical management of non-union patella fracture: a case series and review of the literature. Arch Bone Jt Surg. 2020;8(4):455–62. [DOI: 10.22038/ABJS.2020.49755.2472] [PMID: 34692939]

24. Lenz JE, Schraag AD, Plank L, von Rüden C, Alt V, Weber J. Mapping of patellar fracture patterns: a multicenter study of 237 patients. J Clin Med. 2025;14(4):1335. [DOI: 10.3390/jcm14041335] [PMID: 40004864]

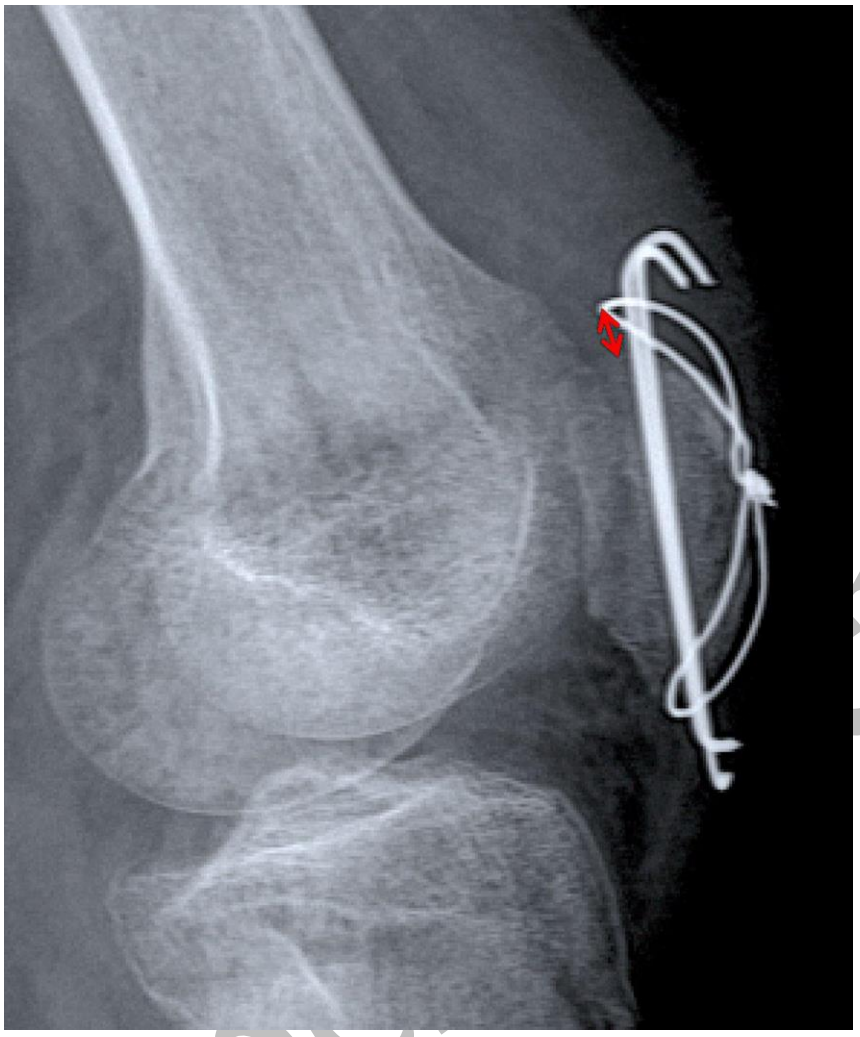

Figure 1. X-ray image of knee with cerclage wire and K-wire fixation

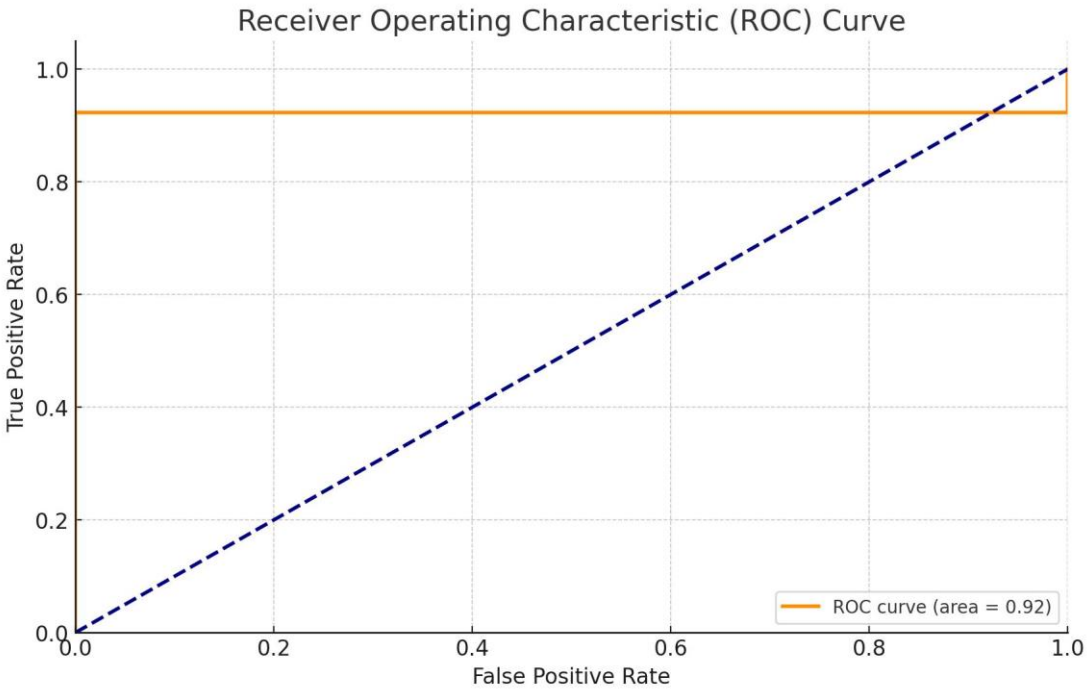

Figure 2. ROC curve predicting implant failure based on cerclage wire distance

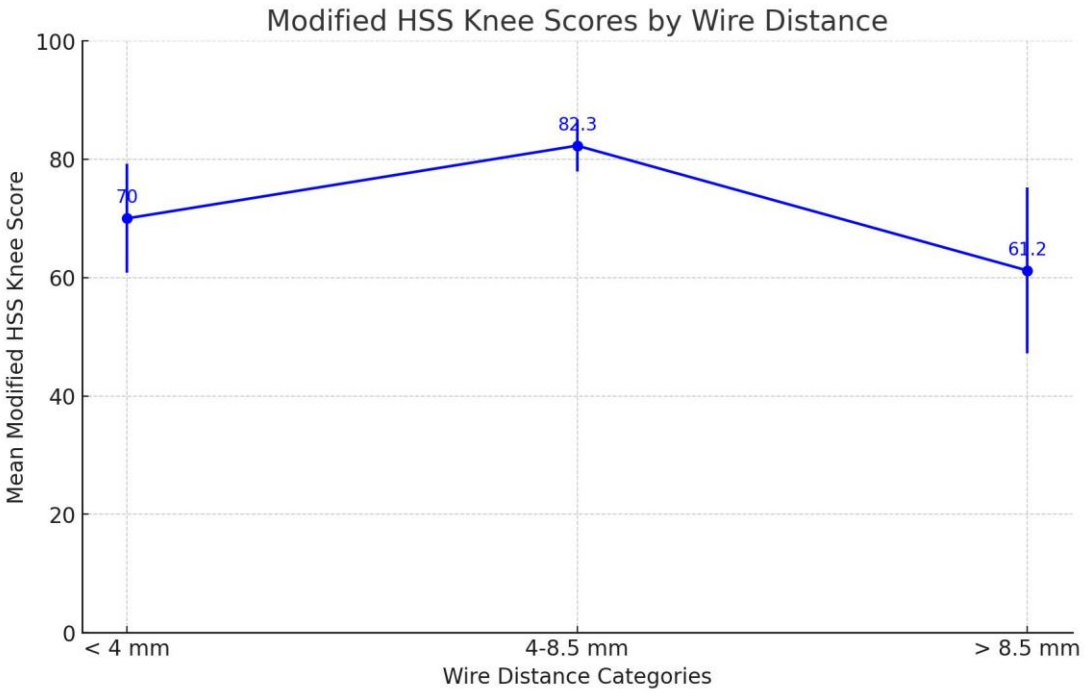

Figure 3. Modified Hospital for Special Surgery (HSS) Knee Scores by wire distance

Table 1. Demographic data

Variable		Value
Age, years		44.8 ± 17.1 (18–65)
Sex	Men	35
	Women	29
Follow-up, months		15.2 ± 5.4 (9–24)
Cerclage wire – patella superior pole distance, mm		6.3 ± 4.03 (1-20.4)
İmplant failure		10
Cerclage wire breakage		2
Cerclage wire displaced over K-wire		7
K-wire migration		1
Nonunion		2
Wound complications		3

Table 2. Parameter measurements

Variables	Group 1 (> 8.5 mm)	Group 2 (< 8.5 mm)	p
Knee ROM	126.6 ± 17.3°	80.6 ± 27.5°	> 0.001
Modified HSS Knee Score	82.3 ± 4.4	61.2 ± 14	> 0.001

ROM – Range of motion; HSS – Hospital for Special Surgery

Table 3. Subgroup analysis

Variables	Group 1 (> 8.5 mm)		p
	> 4 mm	4–8.5 mm	
Knee ROM	120.4 ± 24.6°	132.9 ± 10.1°	0.04
Modified HSS Knee Score	74.2 ± 5.3	90.4 ± 3.5	0.03

ROM – range of motion; HSS – Hospital for Special Surgery

