

# STABILIZACIJA PRELOMA DISTALNOG OKRAJKA KLJUČNE KOSTI NEER IIB TIPA UPOTREBOM TIGHTROPE SISTEMA – PRIKAZ SLUČAJA

PRIKAZ SLUČAJA

CASE REPORT

## STABILIZATION OF NEER IIB TYPE DISTAL CLAVICLE FRACTURE USING THE TIGHTROPE SYSTEM – CASE REPORT

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### SAŽETAK

**Uvod:** Prelomi distalnog okrajka klavikule predstavljaju 10% – 30% svih preloma ove kosti, ali je čak 50% nesraslih i loše sraslih preloma ključne kosti lokalizovano u ovoj regiji. Od svih preloma distalne klavikule najveći procenat komplikacija je u vezi sa prelomima IIB grupe po Neer-ovoj klasifikaciji. Cilj ovog rada je prikaz slučaja pacijentkinje sa prelomom klavikule Neer IIB tipa, lečenog repozicijom i fleksibilnom stabilizacijom korakoklavikularnog zgloba pomoću TightRope sistema.

**Prikaz slučaja:** Pacijentkinja stara 48 godina, povređena u saobraćajnom udesu kao vozač automobila, zadobila je prelom distalnog okrajka leve ključne kosti tipa IIB po Neer-ovoj klasifikaciji. Tri dana nakon povrede, pacijentkinja je operisana indirektnom stabilizacijom korakoklavikularnog zgloba fiksacijom pomoću TightRope sistema. Rehabilitacija je započeta prvog postoperativnog dana i završila se tri meseca nakon operacije, uz postizanje punog obima pokreta u levom ramenu, povratak trofike i snage mišića ramena, nakon čega je usledio povratak uobičajenim životnim i radnim aktivnostima, kao i pre povrede.

**Zaključak:** Iako nema zlatnog standarda u operativnom lečenju ovih povreda, dobri do odlični rezultati postižu se indirektnom metodom stabilizacije i fleksibilnim fiksiranjem korakoklavikularnog zgloba pomoću različitih tipova sutura. Upoređivanje ove metode sa drugim opisanim tehnikama ukazuje da ona ima bolji funkcionalni rezultat, koji se brže postiže, uz manji stepen komplikacija. Funkcionalni rezultati naše pacijentkinje doprinose podacima iz literature i još jednom pokazuju delotvornost ovakvog vida lečenja ovih složenih povreda.

**Ključne reči:** distalna klavikula, prelomi, unutrašnja fiksacija preloma

### ABSTRACT

**Introduction:** Fractures of the distal end of the clavicle account for 10% – 30% of all fractures of this bone, however, they account for as many as 50% of non-unions and malunions in clavicle fractures. Of all distal clavicle fractures, the highest percentage of complications appertain to Neer type IIB fractures. The aim of this paper is to describe the case of a female patient with a Neer type IIB clavicle fracture treated by fracture reduction and flexible stabilization of the coracoclavicular joint using the TightRope system.

**Case report:** A 48-year-old female patient, injured in a traffic accident while driving a car, suffered a Neer type IIB fracture of the distal edge of the left clavicle. Three days after the injury, the patient underwent indirect stabilization surgery of the coracoclavicular joint by fixation, with the application of the TightRope system. Rehabilitation began on the first postoperative day and was completed three months after surgery, with the achievement of full range of motion in the left shoulder, return of muscle tone and strength of the shoulder muscles, followed by a return to everyday life and work activities, as before the injury.

**Conclusion:** Although no gold standard exists in the operative treatment of the above-described injuries, the indirect method of stabilization and flexible fixation of the coracoclavicular joint, using different types of sutures, achieves good to excellent results. Comparing this method with other described techniques indicates that it has a better functional result, which is achieved faster with a lower complication rate. Our patient's functional results contribute to literature data and yet again demonstrate the effectiveness of this type of treatment for these complex injuries.

**Keywords:** distal clavicle, fractures, internal fixation of fractures

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## UVOD

Prelomi distalnog okrajka ključne kosti predstavljaju između 10% – 30% ukupnog broja preloma ove kosti, a po učestalosti se nalaze na drugom mestu, iza preloma dijafize [1–3]. Istovremeno imaju i najveću učestalost nesrastanja i lošeg srastanja, čak i do 50% [1,4]. Prelomi tipa Neer IIB su definisani kao prelomi u predelu korakoklavikularnog (KK) ligamenta, kod kojih je došlo do pucanja konoidnog dela KK ligamenta sa dislokacijom proksimalnog fragmenta [1,5].

U populaciji mlađih osoba, mehanizam povrede je, u najvećem broju slučajeva, direktno dejstvo sile, najčešće kao posledica saobraćajnog traumatizma, pada sa visine, ili kao rezultat sportskih aktivnosti, dok je kod starijih pacijenata češće dejstvo sile niskog intenziteta [5].

Lečenje preloma distalne klavikule Neer IIB tipa je najčešće hirurško, pre svega zbog visoke incidencije nesrastanja i srastanja u lošoj poziciji kod neoperativno lečenih [1,5]. Trenutno ne postoji zlatni standard hirurške tehnike za ovaj tip preloma, već su one, prema konceptu fiksacije, podeljene u sledeće dve grupe: direktna osteosinteza ključne kosti (upotrebom različitih vrsta ploča, zavrtanja i intramedularnih klinova) i indirektna stabilizacija preloma fiksiranjem KK zgloba (upotrebom različitih oblika rigidnog ili fleksibilnog sistema) [1,6,7].

Prema podacima iz literature, ishod svih vrsta hirurškog lečenja se pokazao kao dominantno zadovoljavajući, uz isticanje prednosti upotrebe indirektno fleksibilne fiksacije, kao tehnički lakše i često manje invazivne operativne tehnike, sa kraćim trajanjem operacije, boljim estetskim rezultatima, manjim troškovima lečenja, uz činjenicu da druga operacija i vađenje implantata nisu potrebni [1,2,8,9].

Cilj ovog rada je da se prikaže slučaj pacijentkinje sa prelomom distalnog okrajka ključne kosti Neer IIB tipa, operativno lečenog indirektnom fleksibilnom fiksacijom, upotrebom AC TightRope® (Arthrex, Naples, Florida, USA) sistema, kao i da se prikažu rezultati njenog ranog postoperativnog oporavka.

## PRIKAZ BOLESNIKA

Pacijentkinja, stara 48 godina, javila se u našu ustanovu zbog povrede levog ramena koju je zadobila u saobraćajnom udesu kao vozač automobila, sa tegobama u vidu bola i ograničenja pokreta u levom ramenu, uz prisutni deformitet u regiji levog akromioklavikularnog (AK) zgloba. Neurološki i vaskularni nalazi na povređenoj ruci bili su uredni. Učinjene su standardne radiografije i potvrđeno je postojanje preloma distalnog okrajka leve ključne kosti tipa IIB po Neer-ovoj klasifikaciji (Slika 1). Isključene su druge povrede i bolesti.

## INTRODUCTION

Fractures of the distal end of the clavicle account for 10% – 30% of all fractures of this bone, and are the second most common fractures, after diaphyseal fractures [1–3]. At the same time, they have the greatest frequency of non-unions and malunions – as many as 50% [1,4]. Neer type IIB fractures are defined as fractures in the region of the coracoclavicular (CC) ligament wherein the conoid segment of the CC ligament is disrupted and there is a dislocation of the proximal fragment [1,5].

In the younger population, the mechanism of injury is, in most cases, direct impact of force, usually as the result of traffic traumatism, fall from a height, or as the result of sports activities, while in older patients, the impact of low-intensity force is more common [5].

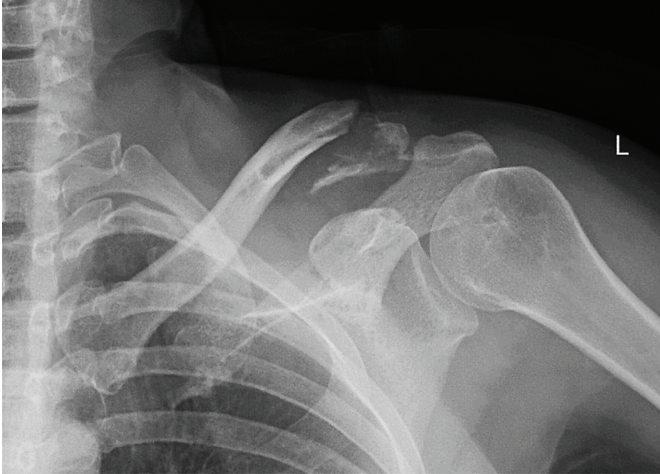
The treatment of Neer type IIB fractures of the distal end of the clavicle is most commonly surgical, primarily due to the high incidence of non-union and malunion in patients treated non-surgically [1,5]. Currently, there is no gold standard regarding the surgical technique for this type of fracture, rather, surgical techniques are, according to the concept of fixation, divided into the following two groups: direct osteosynthesis of the clavicle (with the application of various plates, screws and intramedullary nails) and indirect stabilization of the fracture through fixation of the CC joint (with the use of various systems of rigid or flexible fixation) [1,6,7].

According to the available literature data, the outcomes of all types of surgical treatment have proven to be predominantly satisfactory, with an emphasis on the advantages of the application of indirect flexible fixation, as a technically less challenging and often less invasive surgical technique, with shorter operative time, better esthetic outcomes, lower treatment costs, as well as the fact that a second surgical procedure and removal of the implant are not necessary [1,2,8,9].

The aim of this study is to present the case of a female patient with a Neer type IIB distal clavicle fracture, which was surgically treated with indirect flexible fixation using the AC TightRope® (Arthrex, Naples, Florida, USA) system, as well as to present the results of the patient's early postoperative recovery.

## CASE REPORT

A 48-year-old female patient came to our hospital due to injury to her left shoulder, which she sustained in a traffic accident while driving a car. She presented with pain and limited movement in the left shoulder, with a deformity in the region of the left acromioclavicular (AC) joint. The neurological and vascular findings regarding the injured arm were normal. Standard radiographs were performed and a Neer type IIB left distal



**Slika 1.** Preoperativna radiografija levog ramena u AP projekciji koja pokazuje prelom distalnog okrajka ključne kosti Neer IIB tipa

**Figure 1.** Preoperative AP radiograph of the left shoulder demonstrating the Neer type IIB fracture of the distal end of the clavicle

U cilju evaluacije funkcionalnog stanja zgloba ramena, obima pokreta i bola, korišćen je Constant Shoulder Score (CSS), koji je na prijemu iznosio 12/100 [10,11]. Trećeg dana od nastanka povrede, pacijentkinja je operisana indirektnom stabilizacijom KK zgloba fiksacijom pomoću AC TightRope® sistema.

Operativni zahvat izvršen je u opštoj anesteziji, po pozicioniranju pacijentkinje u „položaj stolice na plaži“ (engl. *beach chair position*). Učinjen je mini-incizioni gornji pristup distalnom okrajku klavikule, konstatovan je kosi prelom distalnog okrajka sa prostiranjem frakturane pukotine u nivou KK ligamenta, uz kompletnu rupturu konoidnog ligamenta i očuvanu funkciju trapezoidnog ligamenta, te stabilan AK zglob.

Prvo je učinjena stabilizacija preloma K-iglom u pravcu budućeg pružanja fiksacionog sistema. Potom je preko igle uvedena kanulirana burgija prečnika 4 mm i formiran je koštani tunel od distalnog dela proksimalnog fragmenta klavikule do donjeg korteksa korakoidnog nastavka skapule. Zatim je kroz kanuliranu burgiju provučena igla vodilja, te je njome izvučen „end-button“ TightRope sistema na donji korteks korakoidnog nastavka. Po izvlačenju dugmeta kroz donji korteks korakoidnog nastavka, učinjena je repozicija preloma pod kontrolom fluoroskopije, a potom dozezanje i fiksacija sistema vezivanjem konaca (Slika 2). Operativna rana zatvorena je na standardni način.

Rani postoperativni period je protekao uredno, bez lokalnih i sistemskih komplikacija. Inicijalno je aplikovana Dezolova imobilizacija, u cilju bolje kontrole postoperativnog bola, koja je nakon jednog dana zamjenjena ortozom, u formi mitele, koja podupire ruku i omogućava delimične pokrete u operisanom ramenu.

clavicle fracture was confirmed (Figure 1). Other injuries and diseases were excluded.

For the purpose of assessing shoulder function, range of movement, and level of pain, the Constant Shoulder Score (CSS) was applied, and, at admission, the score was 12/100 [10,11]. On the third day after injury, the patient was surgically treated with indirect stabilization of the CC joint, i.e., with fixation using the AC TightRope® system.

The surgical procedure was performed in general anesthesia upon placing the patient in the beach chair position. A mini-incision superior approach was made to the distal clavicle, an oblique fracture of the distal clavicle was noted, with propagation of the crack at the level of the CC ligament, with complete rupture of the conoid ligament, preserved function of the trapezoid ligament, and a stable AC joint.

First, the fracture was stabilized with a K-wire in the direction of the position of the planned fixation system. Next, with the help of the wire, a cannulated drill, measuring 4 mm in diameter, was inserted and a bone



**Slika 2.** Intraoperativna radiografija levog ramena u AP projekciji koja pokazuje inicijalnu adekvatnu repoziciju i fiksaciju preloma

**Figure 2.** Intraoperative AP radiograph of the left shoulder showing initial adequate reduction and fixation of the fracture

Prvog postoperativnog dana, pacijentkinja je uključena u program rane rehabilitacije, gde se otpočelo sa intermitentnim pendularnim vežbama, uz restrikciju elevacije i fleksije u operisanom ramenu preko 90 stepeni, tokom šest narednih nedelja. Pacijentkinja je postoperativno zadržana na bolničkom lečenju četiri dana, radi sprovođenja fizikalne terapije i praćenja napretka inicijalne rehabilitacije.

Prva ambulatna kontrola učinjena je četrnaestog dana od operacije, kada su uklonjeni konci iz rane. Operativna rana je zarasla per primam, bez komplikacija. Obim pokreta u levom ramenu bio je ograničen, sa amplitudom fleksije od 45°, ekstenzije od 10°, abdukcije od 40° i spoljašnje rotacije od 10°. CSS na prvoj kontroli iznosio je 37/100.

Druga kontrola je učinjena šest nedelja nakon operacije, uz konstatovan dalji klinički napredak u rehabilitaciji, povećanje obima pokreta, sa amplitudom fleksije od 45°, ekstenzije od 10°, abdukcije od 40° i spoljašnje rotacije od 10°, kao i uz poboljšanje CSS-a, koji je tada iznosio 62/100. Kontrolna radiografija pokazala je prisustvo znakova srastanja preloma u nepromenjenoj poziciji (Slika 3a).

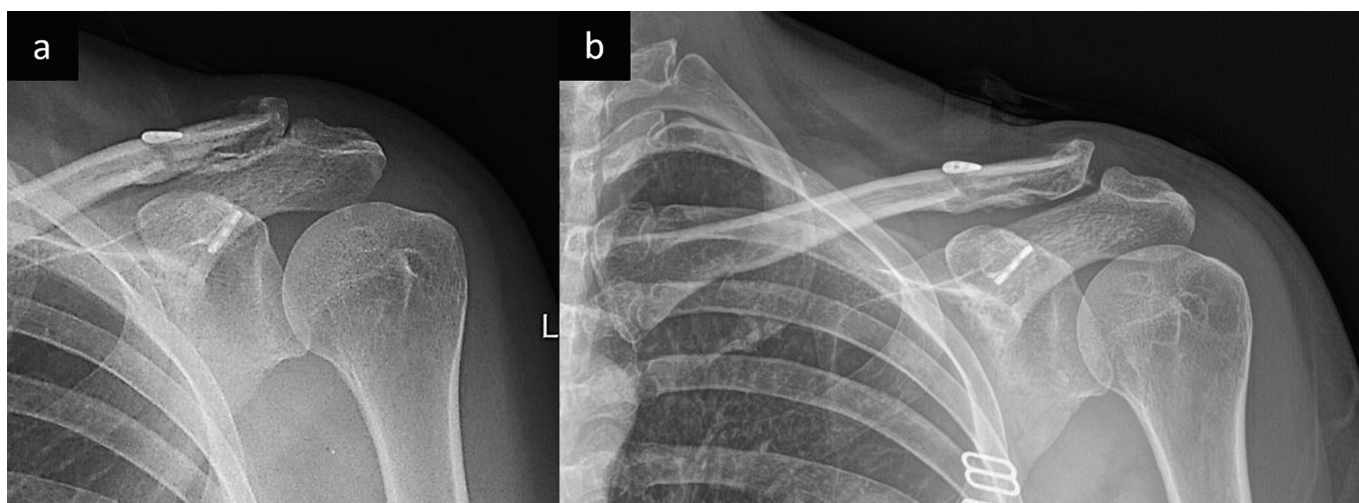
Ruka je tokom prve dve postoperativne nedelje bila imobilisana ortozom, koju je pacijentkinja skidala samo tokom sprovođenja terapije. Tokom sledeće četiri nedelje ortozi je nosila povremeno, da bi nakon tog perioda ortoza bila potpuno uklonjena.

Pacijentkinja je rehabilitaciju završila tri meseca nakon operacije, uz postizanje punog obima pokreta u levom ramenu, povratak trofike i snage mišića ramena, uz CSS 86/100 i povratak uobičajenim životnim i radnim aktivnostima, kao i pre povrede. Kontrolna radiografija, tri meseca od operacije, pokazala je srastanje preloma u nepromenjenoj poziciji, uz očuvanje kon-

tunnel was made from the distal end of the proximal fragment of the clavicle to the inferior cortex of the coracoid process of the scapula. After this, a guiding wire was introduced through the cannulated drill and was used to guide the “end button” system to the inferior cortex of the coracoid process. After the button was guided through the inferior cortex of the coracoid process, the fracture was reduced with fluoroscopy control, and finally, additional tightening and fixation of the system was carried out by tying the sutures (Figure 2). The surgical wound was closed in the standard fashion.

Early postoperative recovery was uneventful, without any local or systemic complications. Desault’s immobilization was initially applied, for the purpose of better postoperative pain management, and was, after one day, replaced with an orthosis, in the form of a mitella, which supports the arm and enables partial movement of the surgically treated shoulder. On the first postoperative day, the patient was included in an early rehabilitation program, wherein she started with intermittent pendulum exercises, with restricted elevation and flexion of the surgically treated shoulder over 90 degrees during the following six weeks. The patient was kept for in-hospital treatment for four days, for the purpose of carrying out physical therapy and following-up the course of the initial rehabilitation.

The first outpatient follow-up was performed on the fourteenth day after the operation, when the sutures were removed. The surgical wound healed per primam, without any complications. The range of movement in the left shoulder was limited, with a flexion amplitude of 45°, an extension amplitude of 10°, an abduction amplitude of 40°, and an amplitude of external rotation of 10°. The CSS at first follow-up was 37/100.



**Slika 3.** Postoperativne radiografije levog ramena u AP projekciji: a) nakon 14 dana od operacije; b) nakon šest nedelja od operacije

**Figure 3.** Postoperative AP radiographs of the left shoulder: a) 14 days after the surgery; b) six weeks after surgery

gruentnosti AK zgloba (Slika 3b). Kliničko praćenje pacijentkinje je nastavljeno naredna četiri meseca tokom kojih nije bilo promene u kliničkom nalazu niti pojave subjektivnih tegoba, uz poslednji zabeleženi CSS skor od 92/100, četiri meseca od operacije.

## DISKUSIJA

Prelomi distalne trećine ključne kosti su karakteristični po prekidu KK ligamenta sa dislokacijom proksimalnog fragmenta naviše, što dovodi do pojave značajne nestabilnosti AK zgloba i predstavlja jedan od razloga za čestu pojavu nesrastanja ovih preloma, naročito u slučajevima kada su pacijenti neoperativno lečeni [1,4,9].

Istorijski posmatrano, osnovni vid lečenja ovih preloma je bila imobilizacija, sve do studije Čarlsa Nira iz 1960. godine, koja je ukazala da prekid KK ligamenta utiče na pojavu veće učestalosti lošeg srastanja i nesrastanja ovih preloma [12,13].

Savremeni pristup neoperativnom lečenju ove povrede podrazumeva imobilizaciju povređenog ramena mitelom ili zavojem po tipu osmice u periodu od 2 – 4 nedelje, te sprovođenje višestepene fizikalne terapije [14]. Ipak, ova vrsta lečenja primenjuje se samo onda kada su fragmenti prelomljene kosti nedislocirani ili minimalno dislocirani, odnosno u slučajevima kada za pacijenta postoji neprihvatljivo visok rizik od operativnog lečenja [15].

Literatura ipak pokazuje da su nestabilnost i značajni stepen dislokacije fragmenata česti kod ove povrede, te su autori mahom saglasni da prelom Neer IIB tipa prevashodno treba lečiti hirurški, nekom od tehnika fiksacije [1,5,7,12,15].

Hirurške tehnike opisane u literaturi mogu se, prema konceptu fiksacije koji se primenjuje, grubo podeliti u sledeće dve grupe: (1) direktna osteosinteza ključne kosti i (2) indirektna stabilizacija preloma pomoću fiksacije KK zgloba [1,7,16]. Nijedna od brojnih opisanih hirurških tehnika koje se svrstavaju u obe pomenute grupe nije se pokazala kao apsolutno superiorna u odnosu na druge [7,17].

Direktna osteosinteza može se izvršiti pomoću različitih vrsta ploča: standardnom prekonturisanom pločom za distalni okrajak klavikule, pločom sa kukastim nastavkom ili ređe, anatomskom pločom za dijafizu klavikule, ili anatomskom pločom za distalni radijus [16,18]. Ređe se vrši osteosinteza preloma pomoću zavrtanja, K-igala i intramedularnih klinova [7,19,20].

Osteosinteza preloma Neer IIB tipa anatomskom pločom i zavrtnjima pokazala je dobre rezultate [21]. Pokazano je da se njome postiže dobra stabilnost na mestu preloma, a sama intraoperativna manipulacija implantatom je jednostavna [18,22]. Sa druge strane, povezana je sa brojnim komplikacijama, pre svega

The second follow-up was six weeks after the operation, with observed further clinical progress during rehabilitation, an increase of the range of movement, with an amplitude of flexion of 45°, an amplitude of extension of 10°, an amplitude of abduction of 40°, and an amplitude of external rotation of 10°, as well as with an improvement of the CSS, which was, at the time, 62/100. Follow-up radiography showed the presence of signs of fracture healing in unchanged position (Figure 3a).

During the first two postoperative weeks, the arm was immobilized with an orthosis, which the patient removed only during physical therapy. During the following four weeks, she wore the orthosis occasionally, after which the orthosis was completely removed.

The patient completed rehabilitation three months after surgery, achieving a full range of motion in her left shoulder, the recovery of the shoulder muscle tone and strength, and a CSS score of 86/100, enabling her to fully return to her everyday activities, as before the injury. A follow-up X-ray, three months after surgery, showed healing of the fracture in unchanged position, with preserved congruency of the AC joint (Figure 3b). Clinical follow-up of the patient was continued for the following four months during which there was no change in the clinical finding nor any development of subjective complaints, with the last recorded CSS of 92/100, four months after surgery.

## DISCUSSION

Fractures of the distal third of the clavicle are characterized by CC ligament rupture with a dislocation of the proximal fragment upwards, which leads to significant instability of the AC joint and is one of the reasons for frequent non-union of these fractures, especially in the case of non-surgically treated patients [1,4,9].

Historically speaking, the main method of treating these fractures was immobilization, until the publishing of the study by Charles Neer, in 1960, which indicated that the rupture of the CC ligament affected the frequency of mal-unions and non-unions in these fractures [12,13].

The modern approach to non-surgical treatment of this injury envisages immobilization if the injured shoulder with a mitella or a figure of eight bandage, for a period of 2 – 4 weeks, as well as multi-step physical therapy [14]. However, this type of treatment is applied only when the fragments of the fractured bone are not dislocated or are minimally dislocated, i.e., in patients whose risk regarding surgery is unacceptably high [15].

However, literature shows that instability and a significant degree of fragment dislocation are frequent in this type of injury, which is why the authors mostly agree that Neer type IIB fractures should primarily be

oštećenjem i „impindžmentom“ (engl. *impingement*) rotatorne manžetne, akromijalnom osteolizom, kao i iritacijom kože iznad implantata i mogućnošću njenog probijanja [18,22].

U literaturi se, kao glavni nedostatak direktne osteosinteze, ističe potreba za drugom intervencijom i vađenjem implantata nakon srastanja preloma [17,19]. Seo i saradnici ističu da je potrebno izvršiti revizionu hirurgiju i ukloniti implantacioni materijal nakon tri meseca od inicijalne operacije, u slučaju da se koristi ploča sa kukastim nastavkom, što povećava mogućnost pojave komplikacija, kao i troškove lečenja [17]. U literaturi se ističu i mogućnosti pomeranja fragmenata kukastim nastavkom prilikom uklanjanja ploče i oštećenja okolnog mekog tkiva, naročito nervnih struktura, što može dovesti do pojave smanjenog senzibiliteta u toj regiji [16,17,23].

Pored upotrebe ploča i zavrtnja, ovaj prelom se može stabilizovati i pomoću K-igala, Nolsovog klina i tension-band sistema, međutim ove tehnike su dominantno napuštene zbog velikog broja komplikacija, pre svega u vidu nesrastanja preloma i migracije igala u unutrašnje organe [20].

Nasuprot osteosintezi ključne kosti, kao savremeni vid lečenja ove povrede opisuje se izolovano fiksiranje KK zgloba, tačnije nadomešćivanje oštećenog konoidnog dela KK ligamenta, pomoću rigidnih ili fleksibilnih materijala [24].

Jin i saradnici su pratili 17 pacijenata sa prelomom distalnog okrajka ključne kosti i rupturom KK ligamenta lečenih stabilizacijom KK zgloba pomoću kanuliranih zavrtnja, ističući postignutu stabilnost na mestu preloma kao glavnu prednost, uz mogućnost ranog započinjanja rehabilitacije [19].

Ipak, ova tehnika je brzo pokazala i svoje mane, koje se ogledaju, pre svega, u mogućem postizanju manjeg obima pokreta, potrebi za novom operacijom radi ekstrakcije zavrtnja nakon srastanja, kao i u mogućem razlabavljenju zavrtnja pre srastanja preloma [19,24]. Želja za eliminisanjem ovih negativnih strana indirektno fiksacije zavrtnjem, uz zadržavanje svih pozitivnih, upravo je rezultirala upotrebom fleksibilne indirektno fiksacije [1,8,9,19,25,26]. Upotreba AC TightRope® sistema se pokazala kao metoda izbora sa višestruko potvrđenim dobrim postoperativnim ishodima [1,8,9,26].

So i saradnici su probili led u ovom polju ortopedske hirurgije i pokazali da je TightRope sistem, uprkos očigledno manjoj invazivnosti u odnosu na druge metode, sasvim dovoljan za postizanje adekvatne stabilnosti preloma i da omogućava rano započinjanje rehabilitacije [9].

Altauel i saradnici su kasnije u svojoj kohortnoj studiji potvrdili pretpostavke o pozitivnim stranama upo-

treated surgically, with one of the fixation techniques [1,5,7,12,15].

According to the concept of fixation applied, surgical techniques described in literature can roughly be divided into the following two groups: (1) direct osteosynthesis of the clavicle and (2) indirect fracture stabilization by CC ligament fixation [1,7,16]. None of the described numerous surgical techniques belonging to one of the abovementioned groups did not prove to be absolutely superior to the others [7,17].

Direct osteosynthesis can be performed with the use of different types of plates: with a standard precontoured plate for the distal clavicle, with a hook plate, or, less frequently, with an anatomical plate for the diaphysis of the clavicle, or an anatomical plate for the distal radius [16,18]. Less frequently, osteosynthesis is performed with screws, K-wires, and intramedullary nails [7,19,20].

Osteosynthesis of a Neer type IIB fracture with an anatomical plate and screws has shown good results [21]. It has been shown that good stability at the site of the fracture is achieved with this technique, while intraoperative manipulation of the implant is simple [18,22]. On the other hand, the technique is connected to numerous complications, primarily to damage and impingement of the rotator cuff, to acromial “osteolysis”, as well as to irritation of the skin above the implant and the possibility of its rupture [18,22].

In literature, the need for a second surgical procedure and the removal of the implant after the fracture has healed, has been reported as the main drawback of direct osteosynthesis [17,19]. Seo et al. stress that it is necessary to perform revision surgery and remove the implant material three months after the initial operation, in case a hook plate is used, which increases the possibility of complications as well as the costs of treatment [17]. The possibility of the fragments being moved by the hook of the plate as well as the possibility of damage to the surrounding soft tissue, especially the nerve structures, while the plate is being removed, which may lead to the reduction of sensitivity in this region, has been pointed out in literature [16,17,23].

In addition to the application of plates and screws, this fracture can be stabilized with K-wires, the Knowles nail, and the tension band system. However, these techniques have predominantly been abandoned due to a large number of complications, primarily in the form of fracture non-union and migration of the wires into internal organs [20].

As an alternative to osteosynthesis of the clavicle, another modern approach to treating this injury is also described – isolated fixation of the CC joint, more precisely repair of the damaged conoid segment of the CC ligament with the help of rigid or flexible materials [24].

trebe TightRope sistema i pritom zabeležili mali broj ranih komplikacija, uz potpuno odsustvo intraoperativnih komplikacija [1].

Dodatne koristi ove metode, u odnosu na direktnu osteosintezu, jesu manji intraoperativni gubitak krvi, kraće trajanje operacije i manji operativni rez sa estetski prihvatljivijim ishodom [27,28]. Komplikacije, kao što su infekcije, nesrastanje preloma, migracije suture ili pucanje konaca, opisane su u literaturi, i one ponekad zahtevaju drugi operativni zahvat, ali ukupno posmatrano one su retke [9,20,26,27].

U slučaju naše pacijentkinje, nije bilo komplikacija, i ona je, u kratkom roku posle operacije, povratila puni obim pokreta i punu funkcionalnost povređenog ramena, te se vratila pređašnjim životnim aktivnostima.

Pored upotrebe izolovane fleksibilne indirektno fiksacije preloma, široko su rasprostranjene i kombinovane tehnike stabilizacije preloma pločom i šrafovim, uz dodatnu stabilizaciju KK zgloba. Šu i saradnici su uporedili dve grupe pacijenata lečene direktnom osteosintezom preloma pločom i kombinacijom ploče sa anchor suturom, i došli do zaključka da kombinacija ovih metoda daje bolji rezultat u vidu stabilnije fiksacije na mestu preloma [25]. Autori, međutim, ističu i nedostatke ove tehnike, pre svega u vidu veće traume okolnih tkiva, uvećanih troškova lečenja i česte potrebe za novom operacijom i uklanjanjem ploče [25].

Ipak, rezultati brojnih studija su pokazali da korišćenje kombinacije ove dve metode, nasuprot izolovanoj fleksibilnoj fiksaciji, ne daje bolje rezultate na kraju lečenja [8,17,25]. Kod pacijenata se u oba slučaja postiže zadovoljavajuća stabilnost zgloba i pun obim pokreta [1,5,8,16,19,25]. Prednost je, štaviše, na strani izolovane fleksibilne fiksacije, pre svega zbog kraćeg vremena potrebnog za potpunu rehabilitaciju i većeg ukupnog zadovoljstva pacijenata [16,17,19,23,25].

Dodatni korak u smanjenu invazivnosti, prilikom stabilizacije preloma distalnog okrajka klavikule, jeste indirektna fiksacija KK zgloba pomoću TightRope sistema, primenom minimalno invazivne, artroskopske hirurgije ramena, čime se dodatno skraćuje vreme hospitalizacije, kao i vreme oporavka [26,29]. Mane su, sa druge strane, složenost operativne tehnike, koja zahteva visoko obučenog hirurga, produženo trajanje operacije i veći troškovi lečenja. Uprkos tome, može se očekivati sve šira upotreba ove tehnike, imajući u vidu njene prednosti [24,30].

## ZAKLJUČAK

Metode hirurškog lečenja opisanih preloma svrstane su u dve široke grupe: (1) direktna osteosinteza klavikule i (2) indirektna osteosinteza stabilizacijom KK zgloba, pre svega pomoću različitih tipova sutura. Iako

Jin et al. monitored 17 patients with distal clavicle fracture and CC ligament rupture treated with CC joint stabilization, with the use of cannulated screws, and emphasized the stability achieved at the site of the fracture as the main advantage, along with the possibility of early start of rehabilitation [19].

However, this technique showed its drawbacks very early on. These are reflected primarily in the possible achievement of a lesser range of motion, in the need for a new operation for the purpose of extracting the screw after union is achieved, as well as in possible loosening of the screw before the fracture has healed [19,24]. The desire to eliminate these shortcomings of indirect fixation with a screw, and at the same time keep all the benefits, resulted in the application of flexible indirect fixation [1,8,9,19,25,26]. The use of the AC TightRope® system has proven to be the method of choice, with multiple reports confirming good postoperative outcomes [1,8,9,26].

Soh et al. were pioneers in this area of orthopedic surgery demonstrating that the TightRope system, despite its obviously lesser invasiveness, as compared to other methods, is indeed adequate for achieving the appropriate stability of the fracture, enabling early commencement of rehabilitation [9].

In their cohort study, Al-Tawil et al. later confirmed the hypotheses on the benefits of TightRope system application, and at the same time recorded a small number of early complications, as well as the complete absence of intraoperative complications [1].

Additional benefits of this method, as compared to direct osteosynthesis, are a lesser intraoperative loss of blood, shorter operative time, and a smaller surgical incision with an esthetically acceptable outcome [27,28]. Complications, such as infections, non-union, migration of the suture or suture rupture, have been described in literature, and sometimes they require a second surgical procedure, however, generally speaking, they are rare [9,20,26,27].

In the case of our patient, there were no complications, and, within a short time after surgery, the patient regained full range of movement and full function of the injured shoulder, returning to her normal everyday activities, as before the injury.

In addition to using isolated flexible indirect fracture fixation, combined techniques of fracture stabilization with a plate and screws, with additional stabilization of the CC joint, are also widely in use. Xu et al. compared two groups of patients treated with direct osteosynthesis of the fracture with the use of a plate and with a combination of a plate and a suture anchor, concluding that a combination of these methods yields a better result as it provides more stable fixation

nema zlatnog standarda u operativnom lečenju ovih povreda, prema podacima iz literature, rezultati lečenja sprovedenog upotrebom indirektno fleksibilne metode stabilizacije KK zglobova su dobri do odlični. Upoređivanje ove metode sa drugim opisanim tehnikama pokazuje da ona ima bolji funkcionalni rezultat, koji se brže postiže, uz manji stepen komplikacija, a posebno se ističe nepostojanje potrebe za drugom hirurškom intervencijom, čime se nedvosmisleno smanjuju troškovi lečenja i vreme korišćenja operacione sale, što u savremenoj praksi predstavlja sve važniji parametar za odabir hirurške tehnike. Funkcionalni rezultati naše pacijentkinje doprinose podacima iz literature i još jednom pokazuju delotvornost ovakvog vida lečenja ovih složenih povreda.

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at the site of the fracture [25]. The authors, however, also point out the drawbacks of this technique, primarily greater trauma to the surrounding tissues, increased cost of treatment, and the frequent need for a new procedure and removal of the plate [25].

However, the results of numerous studies have shown that the use of a combination of these two methods, as opposed to isolated flexible fixation, does not yield better results at the end of treatment [8,17,25]. In both approaches, satisfactory stability of the joint and full range of movement is achieved in patients [1,5,8,16,19,25]. The advantage is, in fact, given to isolated flexible fixation, primarily due to the shorter time period needed for full rehabilitation and a greater overall satisfaction of the patients [16,17,19,23,25].

An additional step towards reducing invasiveness, when stabilizing a fracture of the distal clavicle, is indirect fixation of the CC joint with the TightRope system, using minimally invasive, arthroscopic shoulder surgery, thereby additionally shortening the time of hospital stay, as well as recovery time [26,29]. The drawbacks, on the other hand, are the complexity of the surgical technique, which requires a highly skilled surgeon, prolonged operative time, and increased treatment costs. Nevertheless, bearing in mind its advantages, an increasingly wider application of this technique may be expected [24,30].

## CONCLUSION

The surgical methods for treating the above-described fractures have been categorized into two broad groups: (1) direct osteosynthesis of the clavicle and (2) indirect osteosynthesis through the stabilization of the CC joint, primarily with different types of sutures. Although there is no gold standard in the surgical treatment of these injuries, according to literature data, the results of treatment carried out by applying the method of indirect flexible stabilization of the CC joint are good to excellent. Comparison of this method with other described techniques indicates that it achieves a better functional result, which is accomplished more quickly, and with lesser complications, and as especially significant, without the need for a second surgical procedure, which undoubtedly decreases treatment costs and shortens the operative theater time – this, in modern clinical practice, has become an increasingly important parameter to be considered when choosing the surgical technique. The functional results of our patient contribute to the literature data, and yet again, demonstrate the effectiveness of this form of treatment of these complex injuries.

**Conflict of interest:** None declared.



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