Anatomically Precontoured LCP for Delayed Union of a Medial Third Clavicle Fracture. Case Report with Review of the Literature

Anatomicky preformovaná dlaha (LCP) pro opožděné hojení zlomeniny střední třetiny klíční kosti. Kazuistika a přehled literatury

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SUMMARY

BACKGROUND

Fractures of the medial clavicle third are rare injuries. Even in case of significant fracture displacement, their therapeutic management has been nonoperative. Recently, surgical intervention has become mandatory for displaced fractures types to prevent non-union and functional complaints, but the optimal operative strategy is being discussed controversially.

CASE PRESENTATION

We describe the case of a 63-year-old male patient with a significantly displaced medial clavicle fracture after failed conservative treatment resulting in restricted, painful shoulder function. The patient underwent open reduction and osteosynthesis with an anatomically precontoured locking compression plate (LCP). One year after surgery the patient is free of complaints and has returned to his preinjury activity level without any functional restrictions.

CONCLUSION

As a not yet reported operative approach, anatomically preshaped locking plating seems to be an effective fixation method for displaced fractures of the medial clavicle third. The operative management is described in detail and discussed with the current literature. Based on the presented case, we underline the statement that displaced medial clavicle fractures should be surgically addressed to avoid late damage.

Key words: medial clavicle fracture, locking compression plating, anatomically precontoured plate.

INTRODUCTION

Fractures of the medial third of the clavicle are rare injuries. The reported incidence varies from 2 to 9% of all clavicle fractures in mature patients (9, 13). Except for open fractures, conservative treatment is recommended for non-displaced and slightly displaced fractures. The severity of fracture displacement and concomitant ligaments ruptures have to be considered as instability parameters for therapeutic procedure (11). In case of soft-tissue compromise, however, or if mediastinal structures are at risk due to fracture displacement, an operative intervention is required (14). Newer published reports suggest that surgical treatment should be considered for displaced medial clavicle fractures to prevent non-union and functional complaints (1, 7). In the last decades, diverse surgical techniques have been described for the treatment of medial clavicle fractures including K-wire or plate fixation, interosseous suturing, resection of the medial clavicle end and arthrodesis of the sternoclavicular joint. Recently, the use of small locking plates has been reported for periarticular medial clavicle fractures with good functional outome (8). Nevertheless the optimal operative strategy is being controversally discussed because most studies on the subject have only been case reports or small case series.

Therefore in this context we present the case of a significantly displaced medial clavicle fracture with delayed union after failed conservative treatment resulting in restricted, painful shoulder function. The operative management in terms of the use of an anatomically precontoured locking compression plate (LCP) is described in detail and compared to other plating systems and reconstruction methods as well. To the best of our knowledge, this is the first report on anatomically preshaped locked plating for a medial clavicle fracture.

CASE PRESENTATION

A 63-year-old male patient was presented to our trauma surgery department with significant pain in the right acromioclavicular (AC) and sternoclavicular (SC) joints as well as restricted ROM (range of motion) of his right shoulder joint. Moreover, he complained about shortening of the right shoulder silhouette (Fig. 1A). The patient's anamnesis revealed a fall from a standing height

onto his right shoulder 12 weeks ago. Up to that point, he was medicated with oral narcotics on the diagnosis of shoulder contusion, followed by physiotherapy.

The clinical examination showed an obvious anterior prominence of the right medial clavicle end with pressure pain. Active ROM of the right shoulder was limited for anteversion and abduction (Fig. 1B). Radiographs showed an intact AC joint, whereas a grossly displaced, extraarticular fracture of the medial third of the right clavicle was revealed (Fig. 2). Subsequent computed tomography (CT) scan confirmed an oblique fracture of the medial third without involvement of the SC joint, but with a 28 mm displacement of the lateral midshaft fragment (Figs 2A and 2B). Correspondingly this fracture was classified as type I-B1 according to Robinson et al. and type C according to Throckmorton and Kuhn, respectively (11, 13). Based on patient´s functional restrictions and the significant fracture displacement surgical intervention was indicated.

The patient was placed in a supine position with an anterior longitudinal approach being performed along the right SC joint. A massive, hypertrophic callus formation containing an isolated shaft fragment was detected between the medial end of the clavicle and the lateral midshaft fragment. The medial clavicle end was presented with an only 1-cm bone stock but with an intact articular capsule to the SC joint. The lateral fragment was severely displaced inferiorly and proximally resulting in a significant shortening of the clavicle. The callus formation was completely removed to reference the original fracture ends. The medullary cavity was reamed with a 2.5-mm cortex drill to induce fracture healing. First, a 3.5-mm cortical lag screw was placed in between the midshaft fragments to achieve interfragmentary compression. Next, the fracture was neutralized with an anatomically precontoured locking compression plate (3.5-mm LCP-SA clavicle plate, Synthes, Umkirch, Germany) adapted to the medial, superior-anterior aspect of the clavicle. This low-profile, titanium plate was originally designed for clavicle fractures of the lateral third (Fig. 3). It accommodates the lateral curve of the clavicle shaft and anatomically matches the distal end of the clavicle. Left and right plates in different lengths are available. Distally, it offers multiple options for positioning 2.4-mm locking screws. Moreover, the combination of 3.5-mm locking screws with 3.5-mm non-locking cortical screws in the LCP combi-holes offers intraoperative choice between angular stability and compression along the clavicle shaft. In the current case, the LCP plate was turned for 180 degrees allowing angular stable fixation of the medial fracture fragment with a total of 5 locking screws. No bending of the plate was necessary to be fitted to the anatomy of the medial clavicle third. For postoperative management, patient's right upper extremity was immobilized in a sling for 4 weeks. Passive and active (gravity-assisted) motion of the hand including the elbow joint was started 2 days after surgery under the supervision of a physical therapist. Anteversion and abduction of the shoulder joint was strictly limited to < 90 degrees for 6 weeks. The patient was scheduled

Fig. 1. Marked shortening of the right shoulder silhouette (A) and restricted active ROM (B) of the right shoulder. Restored right shoulder silhouette with correct length of clavicle (C) and full ROM 1 year after surgery (D).

for postoperative follow up visits 3 and 6 weeks and 3 and 6 months after surgery respectively. Depending on the completion of fracture healing signs on radiographs, active ROM was approved.

1 year after surgery the patient presented free of complaints and has regained full ROM of his right shoulder joint. He has returned to his preinjury activity level without any restrictions. Compared to the left unaffected upper extremity the right shoulder silhouette has been totally restored (Figs 1C and 1D). Radiographs and also CT scans show complete fracture healing with correct alignment of the clavicle and elucidate the exact matching of the anatomically preshaped implant to the medial clavicle (Figs 2C and 2D). Neither complications regarding soft tissue nor nerval irritations or implant failure have occured over the postoperative course of time.

DISCUSSION

Fractures of the medial third of the clavicle are reported with varying incidences, but present in general a rare entity (12). Traditionally, the treatment of medial clavicle fractures has been non-operative, even in the presence of significantly displaced fragments. In a series of 614 patients over a 5 years period diagnosed with clavicle fractures Throckmorton and Kuhn identified 57 fractures of the medial third (9.3%) (13). The authors report a higher incidence of medial clavicule fractures since in their study. CT scans with a greater detection rate was performed more often compared to previously published reports using radiography accounting for only 2–6% medial clavicular fractures (11). Throckmorton and Kuhn observed that in most cases medial clavicle fractures were typically associated with multipe trauma due to high energetic impact (13). In their study medial

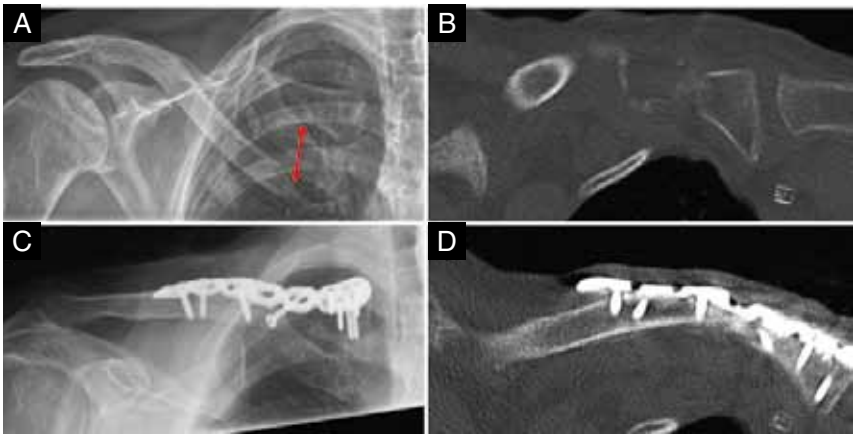

Fig. 2. Preoperative x-ray (A) and CT scan (B) demonstrating the significant displaced fracture of the right medial clavicle (red arrow) and the very short medial fracture fragment. Radiograph (C) 1 year after surgery with complete bony healing. CT scan (D) illustrating the exact matching of the anatomically precontoured LCP to the medial clavicle third.

clavicular fractures were classified by fracture pattern (A = transverse, B = oblique intraarticular, C = oblique extraarticular, D = comminuted, E = avulsion fracture) and extent of displacement (< 2 mm = minimally displaced, 2–10 mm = moderately displaced, >10 mm = severely displaced). According to Robinson et al., medial clavicular fractures were divided into non-displaced and displaced fractures and into extra- and intraarticular fractures, respectively (11).

Up to now the only indication for surgical treatment were open fractures, neurovascular involvement or overlaying soft tissue at risk. Recently, some authors considered that marked displaced fractures of the medial clavicle may result in late damage in terms of pain, cosmetic deformity, weakness in strength and non-union and indicated these fractures for internal fixation (12). As a consequence an effective surgical treatment is mandatory to minimize future complications and functional complaints. However, because of the small number of patients presenting with medial clavicle fractures there has yet not been set up a consensus about a standardized operative procedure.

Several surgical techniques have already been described in the current literature for the repair of displaced medial clavicle fractures. Bartoníček et al. presented a series of 5 patients with 3 patients being treated operatively by cerclage wires (1). These patients suffered from displaced extraarticular fractures of the medial third of the clavicle as it was the case for the presented patient. The authors documented good functional results without patients subjective complaints with a minimum follow-up of 12 months postoperatively. However, a hypertrophic callus formation occurred after surgery and therefore a preterm implant removal was performed in all patients. In general the conventional K-wire-transfixation carries the high risk of migration which may result in severe complications (3). Therefore, this technique is considered as obsolete. The resection of the medial clavicle end provides good functional results, but for cosmetic reasons this method is subject of debate.

During the last five years a few articles have dealt with the operative treatment of displaced medial clavicle fractures using different plating techniques. Gille et al. reported casuistically the modified use of a hook plate for the reconstruction of a medial clavicle fracture with excellent functional outcome (4). Kim et al. described a surgical procedure for displaced medial clavicle fractures using a small T-shaped plate usually implanted for distal radius fractures combined with tension band suturing (6). They recommended this procedure as an easy and effective technique, but did not show any clinical results. Low et al. reported their operative outcome of displaced medial end fractures in 5 patients after a mean follow-up of 3.3 years (7). Four patients including one non-union were treated by plate osteosynthesis. In one case, the fracture was only stabilized with a screw because of a poor bone stock of the medial clavicle end. All fractures showed radiographical signs of union and presented with good function in terms of a mean DASH score of 9.0. In conclusion, the authors voted for an aggressive management of displaced medial fractures to reduce potential complications.

Nevertheless, with special regard to short medial fragments or periarticular fractures, a sufficient fixation by a plate is still challenging for orthopedic surgeons. McKenna successfully performed open reduction and internal fixation of a periarticular medial clavicular fracture by using a small distal radius locking plate (8). He reported this locking plate osteosynthesis to be able to create sufficient stability for the medial clavicle portion based on multipe locking screw fixation.

In the presented case, we used an anatomically precontoured LCP for the reconstruction of a significantly displaced, extraarticular fracture of the medial clavicle third with delayed union. The fracture completely healed without further dislocation leading to a very good postoperative outcome after a follow-up of 12 months. To our knowledge, this method of plate osteosynthesis of a medial clavicle fracture has not been reported previously in

Fig. 3. 3.5-mm LCP-SA clavicle plate (Synthes, Umkirch, Germany) (11).

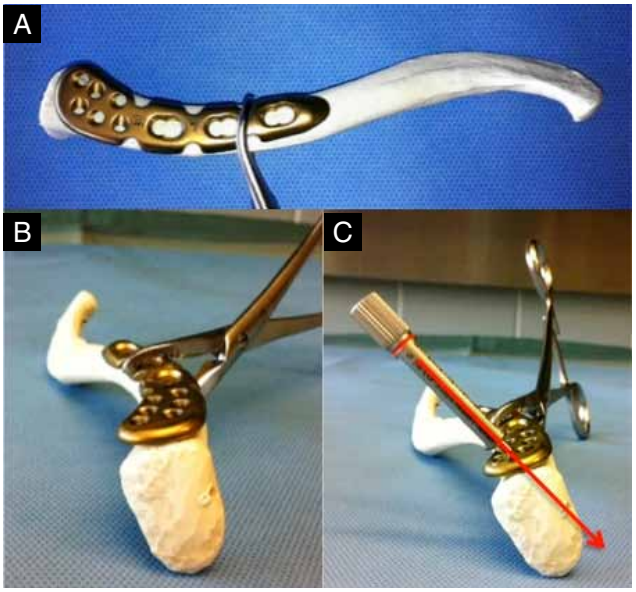

Fig. 4. Saw-bone model of the clavicle demonstrating the accommodation of the 3.5-mm LCP-SA clavicle plate to the medial clavicle third: coronal (A) and sagittal plane (B). The predeterminated direction of 2.4-mm locking screws (red arrow) at the medial end has to be mentioned (C).

the current literature. The used 3.5-mm LCP-SA clavicle plate combines the principle of angular stable fixation with a preformed design, which obviates the need for contouring the plate along the medial clavicle end. Of course the predefined direction of the 2.4-mm locking screws at the "medial" end of the plate has to be taken into account for secure fixation of the medial fracture fragment. In recent studies concerning midshaft clavicle fractures locking plates provided greater stiffness in torsion and less deflection compared to standard implants (2, 10, 15). Inspite of not being originally designed for the anatomical region of the medial clavicle, the implant used in our case can match the medial clavicle third very exactly (Fig. 4). For fractures of the clavicle shaft precontoured locking plates have already been described to be able to adequately match the anatomy with respect to gender of donor specimens (5).

Consent

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

All authors contributed in a significant way in the steps of processing the patient history as well as writing and editing the manuscript. SS and MN conceived of the idea for the study and engaged in writing the first draft of the manuscript. IJB and MB additional participated in its design and coordination and helped to draft the manuscript. SS, MN and PA carried out the surgical procedures and provided rehabilitation. GHS, CK provided research support and gave advice throughout the project. PB has revised the manuscript critically for important intellectual content. All authors read and approved the final manuscript to be published.

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