



Anatomical frame plate osteosynthesis in Ada-Miller Type 2 or 4 scapula fractures

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Objectives: The aim of this prospective study was to evaluate the results of anatomical frame plate osteosynthesis in patients with Ada and Miller Type 2 or 4 scapula fractures.

Methods: Eleven Ada and Miller Type 2 or 4 scapula fractures in nine patients were treated with anatomical frame plate osteosynthesis. The mean follow-up time was 39.8 (12–77) months. The results were evaluated using the Herscovici score.

Results: No complications, such as neurovascular injury, postoperative hematoma, infection, delayed wound healing, implant failure, delayed union, or nonunion occurred. Based on the Herscovici score, the results were excellent.

Conclusion: Osteosynthesis with anatomical frame plates appears to be a safe method that allows early range of motion and that provides excellent results in Ada and Miller Type 2 or 4 scapula fractures.

Key words: Anatomic plate; osteosynthesis; scapula fracture.

Scapula fractures constitute 1% of all fractures and 5% of those involving the shoulder region.^[1] They are typically high-energy fractures^[1-14] and may be associated with injuries to the shoulder, chest, and intra-abdominal organs.^[1,4,5,7-11] They may be treated non-surgically^[3,8,15,16] or surgically.^[14,17-19] However, surgical treatment is recommended with comminuted displaced fractures, glenoid neck or fossa fractures, and scapula fractures associated with ipsilateral shoulder injuries.^[11,14,17-23]

Various osteosynthesis materials, such as reconstruction plates, Sherman plates, and screws can be used in the operative treatment of scapula fractures.^[14,17-19] The most important consideration in scapula surgery is the anatomy of the scapula. During surgery, the muscles must be carefully detached from the scapula. The osteosynthesis mate-

rial should provide a stable fixation and not complicate the reattachment of muscles.

Plates are the most common implant in the surgical treatment of scapular fractures. Due to the thinness of the scapula at the infraspinatus fossa the screws used for the plates must be short, which may result in plate failure.^[24] However, correct plate placement can enable the use of longer screws in comminuted scapular fractures.

The aim of this prospective study was to evaluate the results of anatomical frame plate osteosynthesis in patients with Ada and Miller Type 2 or 4 scapula fractures.

Patients and methods

Between 2002 and 2007, anatomical frame plates were used to treat 11 Ada and Miller Type 2 or 4

scapula fractures in 9 patients (1 woman and 8 men; mean age: 37.3 years; range: 19 to 52 years). These patients were followed up prospectively. Patients with a minimal follow-up time of 12 months were included in this study. The injuries resulted from motor vehicle accidents in 7 patients and high falls in 2. All patients had additional injuries (Table 1). The patients underwent scapula surgery in a mean of 7 (1-15) days after their injuries. All of the scapula fractures were closed fractures. Three were bilateral (one scapula fracture was not treated surgically), four were right-sided, and two were left-sided.

For diagnosis, anteroposterior and lateral scapula radiographs were obtained. Computerized tomography (CT) was also performed to determine the displacement and angulation of the scapula fracture. The fractures were categorized according to the classification of Hardegger et al.^[22] as modified by Ada and Miller^[10] (Fig. 1 and Table 1).

Indications for surgery included scapula neck fractures associated with ipsilateral clavicle and comminuted scapula body fractures, angulation of the scapula neck fracture by more than 40 degrees, and displaced fracture fragments of the scapula body.^[6,10,11,14,22,25-27] All surgeries were performed by the first author using posterior Judet incision.^[10]

The anatomical plates (Hipokrat, İzmir, Turkey) (patent number: 200501013) we used were designed by the first author of this study, to encircle the infraspinatus fossa.^[14,28] Consequently, the plates can be fixed on the thicker edges of the scapula (Fig. 2). Three types of separate stainless steel 1.8 mm plates were manufactured for use on the right and left sides. Plate 1 is a lateral superior plate for the lateral border, glenoid neck, and upper infraspinatus fossa. Plate 2 is an inferior plate for the inferior corner of the scapula body and plate 3 is a medial superior plate for the medial border and upper infraspinatus

Table 1. Demographic and injury data.

Patient	Age (years)	Gender	Injured side	Scapula classification	Plates used for scapular osteosynthesis	Additional injuries	Treatment of the additional fractures	Length of follow-up (months)	Herscovici score
1	45	Male	R* and L*	Bilateral Type 2C + 4	R-4 plates L-3 plates	4th and 5th thoracic vertebrae fractures	Cervicothoracolumbar orthosis	77	R-14 L-14
2	23	Male	R	Type 2A + 4	R-3 plates			65	15
3	43	Female	R and L	L-Type 4 R-Type 2 B + 4	R-2 plates L-3 plates	Left iliac wing fracture	Osteosynthesis with two plates	56	R-14 L-15
4	24	Male	R	Type 2A + 2C	R-2 plates			46	15
5	44	Male	R	Type 2C	R-2 plates	Bilateral clavicle fractures	Bilateral osteosynthesis with plates	44	14
6	38	Male	L	Type 2C and displaced lateral border	L-2 plates	Left radius and ulna and right pubic fractures	Radial and ulnar osteosynthesis with plates, conservative treatment for the pubic fracture	23	15
7	52	Male	L	Type 2C + 4	L-4 plates	Left clavicle fractures, hemopneumothorax	Osteosynthesis with plates, chest tube drainage	18	14
8	48	Male	R and L	L-Type 2C R-Non-displaced Type 4	L-3 plates R-non-operative	Hemopneumothorax	Chest tube drainage	18	L-15 R-16
9	19	Male	R	R Type 2C + 4	R-3 plates	Left clavicle fractures, right distal radius fractures, hemopneumothorax	Clavicular osteosynthesis with plates, cast for the distal radius fracture, chest tube drainage	12	15

*R=right; L=left

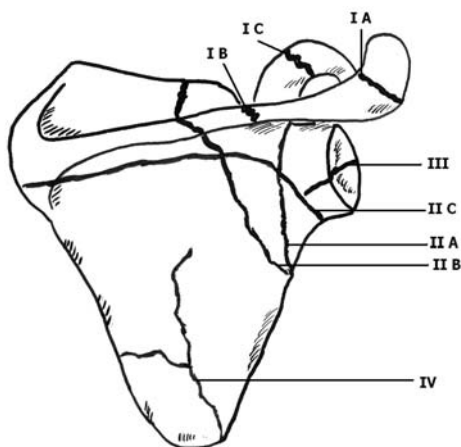


Fig. 1. Scapula fracture classification modified by Ada and Miller.

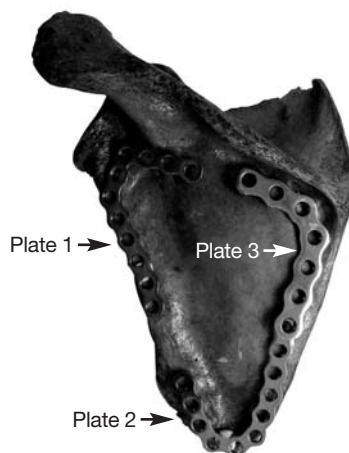


Fig. 2. Anatomical frame plates for the left scapula.

tus fossa. Cortical screws of 3.5 mm in outer diameter and 2.7 mm in inner diameter were used.

The patient was placed in the prone position with a support under the shoulder, allowing the manipulation of the arm during the surgery and the surgical site was prepared. A Judet incision was used and during exposure, the arm was held in adduction,^[10] The infraspinatus muscle was detached subperiosteally, in line with the skin incision. The inferior angle, lateral margin, and glenoid neck are then exposed to allow access to the fracture fragments. After reduction, the plates were chosen according to the fracture configuration. If three plates were required, the medio-superior "plate 3" was fixed first, followed by the inferior "plate 2", and finally the superolateral "plate 1" (Fig. 2). Stability was evaluated through the intraoperative manipulation of the arm.

Drains were removed two days postoperatively. Shoulder and elbow range of motion exercises were begun three days postoperatively and home exercises were provided upon discharge (Fig. 3). An arm sling was used for the first 4-6 weeks. The majority of patients were allowed to return to work after 6 weeks although two laborers were only allowed to return to work after 10 and 12 weeks.

The mean follow-up time was 39.8 (range: 12-77) months. Pain, quality of life, shoulder range of motion and muscle strength were evaluated with Herscovici scoring system during the final examination.^[3] Each of these four parameters were scored on a scale ranging from 0 to 4. Scores of 13-16 were

considered excellent, 9-12 good, 5-8 moderate, and 0-4 poor.

Results

The types of scapula fracture, plates applied, and additional injuries and their treatments are summarized in Table 1.

No surgical complications, such as neurovascular injury or postoperative hematoma, infections,



Fig. 3. Back view of a patient at 12th day postoperatively.

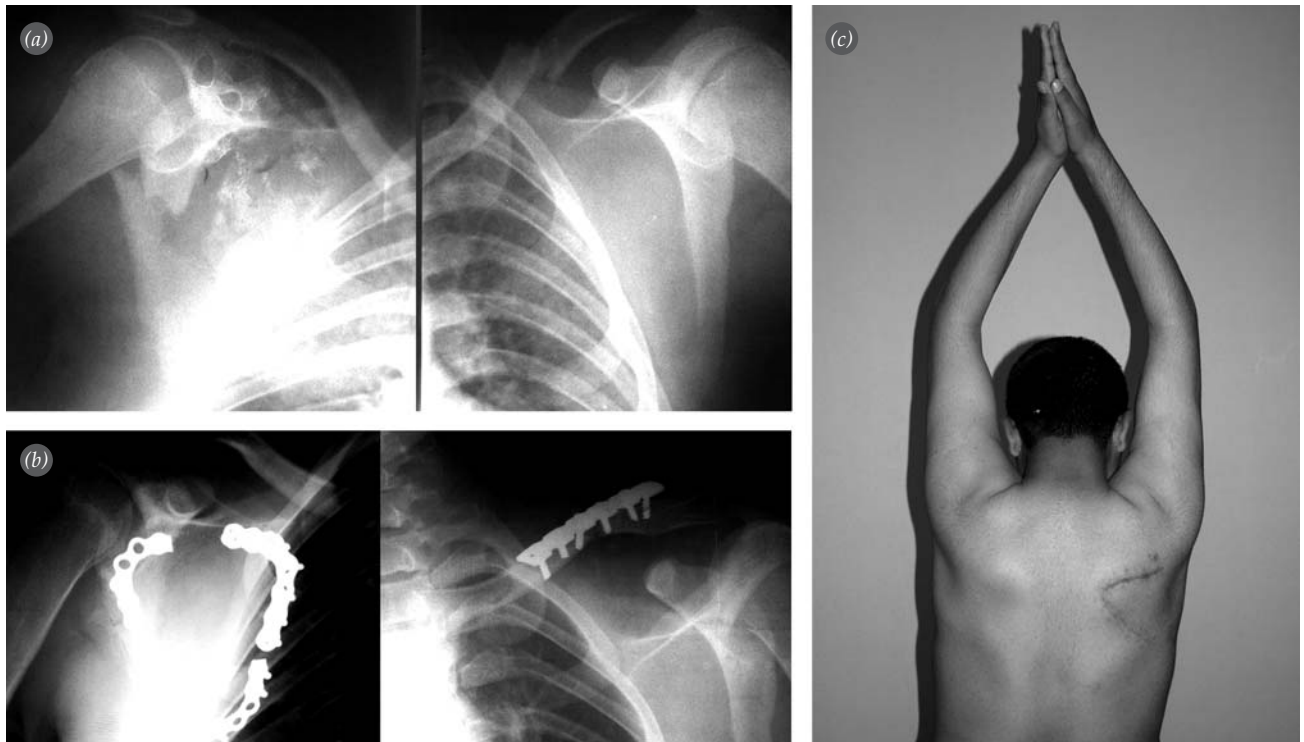


Fig. 4. Preoperative X-rays of a patient. Note the fractures of the right scapula and left clavicle (a); Postoperative right scapula and left clavicle X-rays (b); and a functional view 4 months postoperatively (c).

delayed wound healing, muscle atrophy, implant failure, delayed union, or nonunion occurred.

In the final examination, Herscovici scores were excellent (between 13 and 16) (Table 1 and Fig. 4). All patients were able to return to their jobs.

The original plates ended near the fracture lines in two patients. Consequently, a fourth plate was used in these two cases.

Discussion

In 1910, Cotton described the first radiological view and Albin Lambotte described the first internal fixation of scapula fractures.^[29] In 1939, Dupont and Evrard first fixed the lateral border of the scapula with Sherman plates.^[29] Robert Judet defined his posterior extensile approach in 1964.^[10,29] Magerl defined the principles of stable internal fixation of scapula fractures in 1974 and the principles were detailed by Izadpanah in 1975.^[29] Ganz and Noesberger defined the importance of ipsilateral association of glenoid neck and clavicle fractures and acromioclavicular dislocation, currently called the “floating shoulder”.^[3,29] In 1991, Ada and Miller

published their results on 113 scapula fractures and their classification.^[10] The number of extra-articular scapula fractures treated operatively has increased steadily since these fractures were first defined.^[30] Our clinic surgically treats displaced scapula fractures.

Various surgical indications for scapula fractures have historically been applied.^[10,11,14,17,18,20-23] As they are non-displaced, most scapula fractures are usually treated nonsurgically.^[1,2,8,15] Our surgically treated patients had either displaced glenoid neck fractures, additional fractures, or comminuted displaced scapula body fractures. These are classified as Type 2 and 4 fractures according to Hardegger et al. as modified by Ada and Miller.^[10,22] Scapula fractures with no additional contiguous bone fractures and no marked displacement of the fragments were all treated nonsurgically.^[2,8,15,16]

The thinness of the scapula necessitates the use of short screws to obtain stable fixation. Longer screws can be used in plates over the thicker sides of the scapula, while screws used for the infraspinatus fossa must be short. The lateral edge between the



Fig. 5. The new extended anatomical frame plates for the left scapula.

inferior glenoid and inferior corner of the scapula is between 9.2 and 11.3 mm, the lateral and medial edges of the inferior corner between 4.6 and 9.3 mm, and the medial edge between the inferior corner and spine of the scapula between 3.5 and 4.9 mm thick.^[24] In contrast, the infraspinatus fossa is between 2.7 and 3.5 mm thick.^[24] Because the edges of the thin scapular body are relatively thick, the shape and location of our anatomical stainless-steel frame plates were designed specifically for these relatively thick edges of the scapular body.

During the surgical approach an under-shoulder support may help the exposure of the glenoid. Manipulating the arm may help in the reduction of the fracture. During exposure, the shoulder should be held in adduction to protect the axillary nerve and vessels. In comminuted scapula body fractures, frame plates can be used, although some fracture fragments at the middle of the scapula body may remain unfixated. In such fractures, additional bridge plates can be used from the medial margin to the lateral. Glenoid neck reduction is important for the outcome of surgery. Special clamps, flexible screwdrivers, and screw holders are often necessary, especially for the inferior side of the glenoid neck at the lateral margin. Lateral margin may be reduced more easily after fixation with the superomedial "Plate 3" and inferior "Plate 2" plates (Fig. 2).

We had cases where the edges of the frame plates only reached the fracture line during the operation. The senior author designed new long plates that completely frame the edges of the scapula to overcome this problem (Fig. 5). These plates can be shortened.

Our anatomical frame plates have two main advantages: they stabilize the fracture fragments by encircling the scapula body and they are adapted to the relatively thicker regions, allowing the use of longer screws.

While some authors are still against an early mobilization program after the surgical treatment of scapula fractures,^[17,20] the stable osteosynthesis of the frame plates encourages the use of early range of motion exercises on the third day following the operation.

None of the patients had implant failure or experienced muscle atrophy, weakness, or range of motion limitation. These results lead us to the conclusion that the plates provide sufficient stabilization during the postoperative period. We believe that the most important factor determining treatment success was the early introduction of motion exercises.

The low number of cases (n=11) in our series was the limitation of our study, yet, this was larger than some series in the literature.^[10,11,14,17,18,20-22]

In conclusion, our specially designed anatomical frame plates appear to be a safe and effective method for the osteosynthesis of Adair and Miller Type 2 and Type 4 scapula fractures. Their stable osteosynthesis may allow early mobilization with excellent treatment results.

Conflicts of Interest: No conflicts declared.

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