

Spiral-medial butterfly fractures (AO-12-B1) in distal diaphysis of humerus with rotational forces: preliminary results of open reduction and plate-screw fixation

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Abstract. – OBJECTIVE: Humerus shaft fractures are frequent injuries in orthopedic practice and generally occurs with direct and indirect traumas. While the most of these fractures can be managed with conservative methods, in some situations surgery is needed. The aim of this study is to define a different mechanism and treatment result of humerus spiral fractures with medial butterfly fragment (AO-12-B1).

PATIENTS AND METHODS: Between 2010 and 2013, 11 patients who had undergone surgery for spiral humerus shaft fracture with medial large butterfly fragment (AO type 12-B1) resulting from a motor vehicle accident were enrolled to the study. All data was retrieved from the hospital's database retrospectively. All fractures were closed type and all of the patients were treated with open reduction and plate osteosynthesis through lateral approach. Elbow and shoulder ROMs were examined for functional outcomes. The DASH (Disabilities of the Arm, Shoulder and Hand) scoring system was applied at the final follow-up visit.

RESULTS: There were 7 male and 4 female patients with a mean age of 36 years (range, 28-50 years). All of the fractures occurred with same mechanism resulting from motor vehicle accident. Conservative treatment was not considered for any of the cases. The mean time to surgery was 2 days (1-3 days). The mean postoperative follow-up period was 14 months (6-24 months). All fractures had healed completely at 3 months postoperatively. At the final follow-up visit the mean DASH score was 4.2 (3.3-6.7).

CONCLUSIONS: Humerus spiral shaft fractures with a large medial butterfly fragment can be seen in dashboard injuries. It is important to fix the medial large fragment anatomically and minimal invasively in order to achieve union and not to disturb the vascular supply.

Key Words:

Humerus fracture; Butterfly fracture; Open reduction; Plate-screw fixation.

Introduction

Humeral shaft fractures comprise 3% of all orthopedic injuries and typically occurs with direct trauma and indirect trauma due to activities where the rotational stresses are great, particularly in arm wrestling and throwing activities^{1,2}. While most humeral shaft fractures can be treated conservatively, surgery is indicated if satisfactory position cannot be achieved with conservative methods or when a fracture is segmental, a fracture is pathological, associated extremity injuries require early mobilization, a fracture is associated with major vascular injuries, and floating elbow. Specific fractures such as spiral type with butterfly fragment (AO-12-B1) are a relative indication for surgery as this type of fractures require patient compliance, close observation and may result in fracture deformity that exceed tolerable limits^{1,3,4}. Although spiral humerus shaft fractures with butterfly fragment have been reported in some studies⁵⁻⁷ there is lack of specific information about the injury mechanism and treatment method.

In this study, it was aimed to present another cause of AO-12-B1 fractures other than throwing and arm wrestling activities and to report the clinical and radiological results of open reduction and plate osteosynthesis in this specific type of injury.

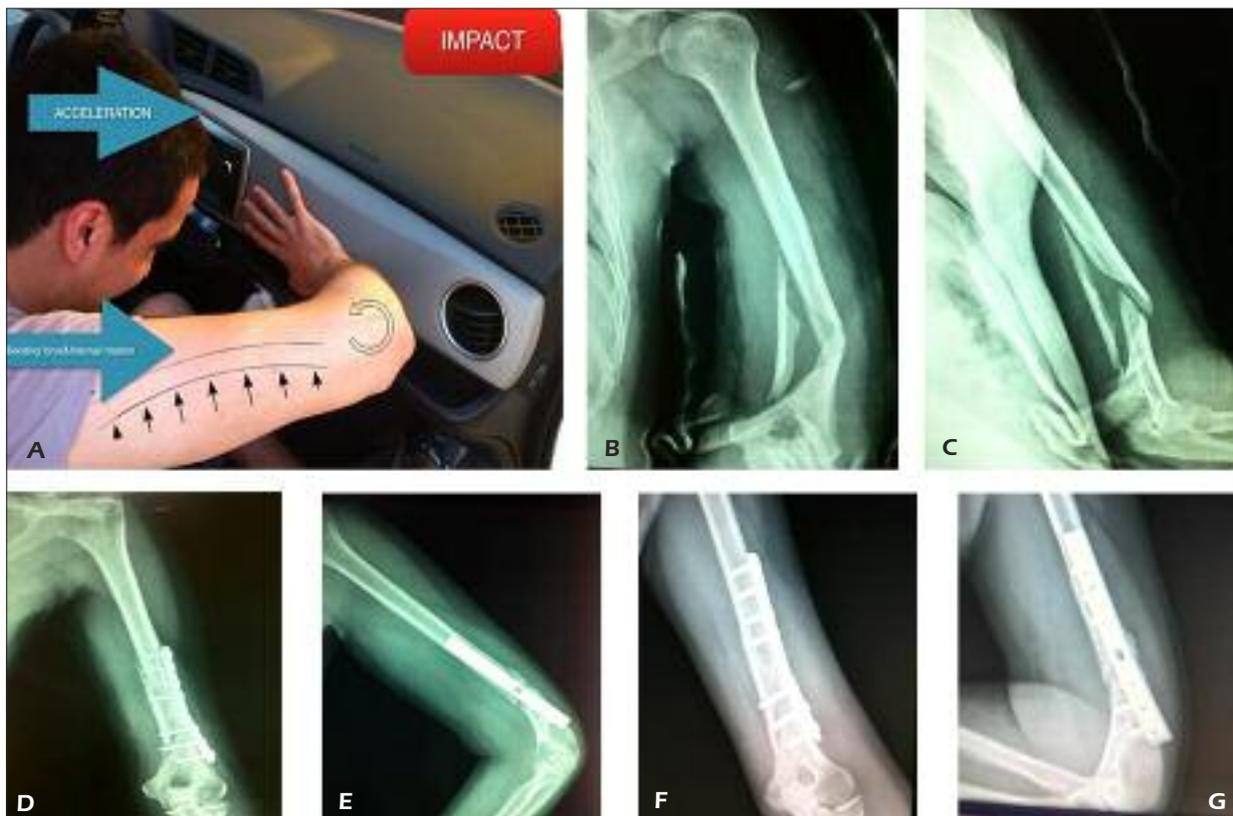


Figure 1. *A*, Illustration of the trauma mechanism of spiral humerus fracture with medial butterfly fragment due to a motor-vehicle accident. *B, C*, Preoperative humerus radiographies of a 36-year old man with a left humerus spiral fracture with displaced medial butterfly fragment resulting from a motor-vehicle accident. *D, E*, Postoperative humerus radiographies of the same patient. *F, G*, Humerus radiographies at postoperative 3rd month.

Patients and Methods

This retrospective study included 11 patients who had undergone surgery for spiral humerus shaft fracture with medial large butterfly fragment (AO type 12-B1) resulting from a motor vehicle accident between 2010 and 2013 (Figure 1A, B, C). Demographic data of the patients, injury mechanism and preoperative clinical findings were evaluated from the clinic database. All fractures were closed type and all of the patients were treated with open reduction and plate osteosynthesis through lateral approach. None of the patients had radial nerve palsy at preoperatively and postoperatively phase. A large medial butterfly fragment was pulled and reduced anatomically with 4.5 mm lag screws through the pre-contoured narrow 4.5 mm dynamic compression plate's holes without stripping the periosteum in order to protect the blood supply (Figure 1D-E).

A long arm splint was applied for three days postoperatively and, then, passive elbow and shoulder motion was started immediately. Active ROM exercises were allowed 3 weeks postoperatively. Postoperative clinical and radiological evaluation was performed monthly. Fracture healing was evaluated with direct radiographies and clinical examination. Elbow and shoulder ROMs were examined for functional outcomes. The DASH (Disabilities of the Arm, Shoulder and Hand) scoring system was applied at the final follow-up visit.

Results

Of the 11 patients included in the study, 7 were male and 4 were female, with a mean age of 36 years (range, 28-50 years). All fractures had resulted from motor vehicle accidents. The patient histories revealed that none of them were wearing a seatbelt at the time of the accident.

Nine patients were sitting in the right-side front seat of the car and had a right-sided humerus fracture as a result of supporting their bodies with their right upper extremity against the dashboard at the time of the collision (Figure 1A). One patient was in a bus during the accident, grabbed the back of the seat in front, following which he had severe pain in the right arm. The final patient had a left humerus fracture. He had been the driver of the vehicle and supported his body with his left upper extremity by grabbing the steering wheel. Conservative treatment was not considered for any of the cases. The mean time to surgery was 2 days (1-3 days). Before surgery, none of the patients had neurological or vascular compromise.

The mean postoperative follow-up period was 14 months (6-24 months). All fractures had healed completely at 3 months postoperatively (Figure 1F-G). No patients had delayed union, non-union or infection. One patient had temporary radial nerve palsy, which was determined to have resolved 3 months postoperatively. No patient had limitation of shoulder motion. Two patients had minimal elbow extension loss (less than 10°). At the final follow-up visit, the DASH scoring system was applied to all patients and the mean DASH score was 4.2 (3.3-6.7).

Discussion

Humerus diaphyseal spiral fracture with medial large butterfly fragment has a different trauma mechanism compared to other types⁸⁻¹². Furthermore, this fracture type constitutes the most problematic group to treat⁵. In literature, the most commonly accepted trauma mechanism is a combination of bending and torsional forces^{1,7,9,12}. This combination generally results in an oblique fracture with or without a butterfly fragment and radial nerve is at great risk between fracture fragments¹. Most studies that focus on this trauma mechanism are related with arm wrestling and throwing activities. Thus, Ogawa et al⁸ reported 30 humeral shaft fractures resulting from arm wrestling where the rotational stresses are great. In his report, 23% of all fractures had a medial butterfly fragment. Similarly, the same authors analyzed 90 patients with humeral shaft fractures resulted from throwing activities. All fractures were spiral and 28% were accompanied by a medial butterfly fragment⁹. However, the authors did not clearly explain the specific mechanism of

trauma that is related to a spiral fracture accompanied by a butterfly fragment. Sakai et al¹² have investigated the mechanism of humeral shaft fractures in throwing activities using a computer simulation and found that the maximum stress concentration is seen in the distal shaft during throwing, which may result in a spiral shaft fracture. However, in their simulation, they did not create a spiral fracture with a butterfly fragment and again the main cause of the spiral shaft fractures was the throwing activity. In the current study, the trauma mechanism in 11 cases of spiral humerus fracture with large medial butterfly fragment was evaluated. All the patients had tried to support their bodies with their upper extremity to compensate for the lack of a seat belt at the time of collision. As illustrated in Figure 1A, collision of the vehicle creates a large acceleration force on the body and this acceleration force results in a combination of bending and great internal rotation force on the upper extremity and therefore in humerus which tries to support the body against the dashboard. Internal rotation generates spiral fracture. Again butterfly fragment is formed in the concave side of bending forces. Therefore, the combination of bending and torsional forces causes this type of fracture. To the best of our knowledge, there are no specific studies or data in literature which report spiral humerus fracture with medial butterfly fragment resulting from a motor vehicle accident.

AO 12-B1 fractures can be both treated with conservative and surgical measures. However conservative treatment requires great patient compliance and close observation. Ring et al⁵ stated that nonunions after functional bracing are more likely to follow spiral/oblique fractures. In their series, the fracture pattern was oblique or spiral in 27 of a total of 32 patients with failed brace treatment and non-union. Furthermore, a butterfly fragment had accompanied 11 of these 27 patients. In fact, a spiral shaft fracture with a large medial butterfly fragment (AO-12-B1) is generally unstable and it is difficult to maintain acceptable reduction due to the lack of medial support and relatively distal-sided position of the fracture pattern. Furthermore, a large medial butterfly fragment may lead to a lack of contact surface of the major diaphyseal fragments due to the soft tissues that come between the broken fragments. Therefore, this unstable pattern of the fracture requires a long immobilization time of the upper extremity for union and hence prevents

early rehabilitation. So the surgical option should be kept in mind for this specific type of fracture for early rehabilitation and union. However, during the surgery, as stated by Laing et al¹³, it is important not to disrupt the integrity of the vascular supply of the medial fragment as the main nutrient artery enters the humeral shaft from the medial side at the junction between the middle and distal third of the humerus where the medial fragment is probably located. Otherwise, this vascular compromise can result in non-union and early implant failures due to avascular necrosis of the medial fragment. So, the medial butterfly fragment should be fixed anatomically and biologically as far as possible without disrupting the medially attached soft tissues to eliminate the possibility of injury to the nutrient blood vessels. One can consider intra-medullary nailing in this type of fracture. However, large butterfly fragment and spiral fracture type makes reduction more difficult. Additionally intramedullary fixation is technically more demanding and has higher rate of complications¹⁴. In the current study, surgery with plate and screws was considered as the first choice of treatment for early rehabilitation and union. The medial fragment was anatomically fixed with lag screws through the laterally placed plate's holes under a lateral approach without disrupting the blood supply of the medial fragment. Passive shoulder and elbow range of motion exercises were started immediately and active ROM was allowed three weeks later. Only two patients had minimal elbow extension loss and there were no union problems in any case. At the final visit, the DASH scores were comparable with those in literature.

Conclusions

Humerus spiral shaft fractures with a large medial butterfly fragment can be seen in dashboard injuries in motor vehicle accidents with a mechanism similar to that seen in throwing or arm wrestling activities. It is important to fix the medial large fragment anatomically and minimal invasively in order to achieve union and not to disturb the vascular supply.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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