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Proximal Humerus comminuted fracture: Treated with locking compression plate and fibular strut autograft: A case report

Ramesh Muthu[1], Muhammad Nirmal[2], Agus Foead[3], Thevarayan[4], Sazali Salleh[5]

[1, 2, 4, 5] Department of Orthopaedic Surgery, Hospital Tengku Ampuan Afzan Pahang, Jalan Tanah Putih, Kuantan, Pahang, Malaysia

[3] Department of Orthopaedic Surgery, School of Medicine, Perdana University-Royal College of Surgeons in Ireland, Jalan MAEPS Perdana, Serdang, Selangor, Malaysia

Abstract
Comminuted fracture of proximal humerus with limited bone stock in young adults is challenging. There are various modes of fixation for proximal humerus fracture such as percutaneous Kirshner wiring, screw fixation, plating, intramedullary nail fixation and hemiarthroplasty. We reported a four-part proximal humerus fracture treated with locking compression plate and fibular strut autograft. Our purpose was to augment pull-out strength of the locking screws and increase stability of the construct.

Keywords: proximal humeral fracture, bone stock, locking compression plate, fibular strut graft.

Introduction
In the literature, proximal humeral fractures account for approximately 4% to 5% of all fractures, many of which could be managed nonoperatively [1]. However comminuted fractures of proximal humerus with limited bone stock in young patients remain a challenge. Besides to achieve stable fixation, the major goals are to prevent non-union, osteonecrosis and post-traumatic osteoarthritis of the glenohumeral joint. Supplementing fixation with cancellous bone graft to fill the bone defect has been the solution by many surgeons for decades. Another option to think of is nonvascularized strut grafts to meet this challenging fixation. In this report, we used a locking compression plate with fibular strut graft for bridging a comminuted fracture of proximal humerus, This fibular strut graft enhances the pull-out strength of the screws of the locking compression plate. This procedure was described recently in biomechanical studies which showing that fibular strut graft provides additional medial support and prevents varus malalignment [2].

Case Report
A 36-year-old man was brought to our emergency department following a road traffic accident. He was riding a motorcycle and had an head-on collision with a car. He fell off his bike and complained of pain and inability to move his right shoulder. Aside from swelling at his right upper arm, he also felt numbness and tingling sensation on his right ring and little fingers. Physical examination revealed marked swelling and tenderness extending from upper to middle part of his right arm. There were bruises over the swelling without any evidence of penetrating injury. We noted clawing and weakness at his right ring and little fingers as well. There was no injury in other parts of the body. Plain radiographs showed empty glenoid with comminuted fracture of right humeral head. The laboratory result was in normal range. We proceeded with CT scan with 3D reconstruction, which confirmed four-part comminuted proximal humerus fracture with significant displacement of fracture fragments (Fig. 1). He was admitted and applied temporary U-slab. The definitive plan of open reduction and fixation with proximal humeral interlocking system (PHILOS) plate augmented with fibular strut graft was proceeded shortly after admission. Postoperative was uneventful and his right arm was kept on an arm sling for a period of 6 weeks.

Rehabilitation ensued with pendulum and self-assisted circumduction exercise, and followed by gradual passive range of motion (ROM) exercise for 6 weeks as tolerated. Post-operative follow-up at three months, the patient had less pain over his right shoulder however the clawing of the ring and little fingers were still present. Plain radiograph showed stable fixation without loosening or pull-out of the implant.

Legends

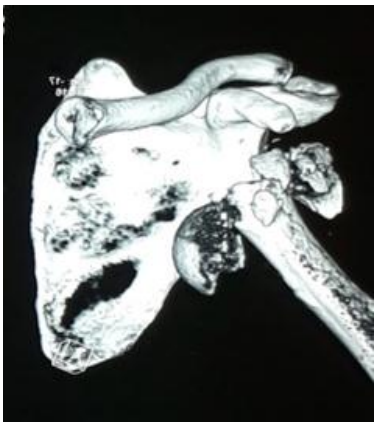

Fig 1: CT scan shows four-part fracture of proximal humerus.

Surgical technique in harvesting fibular graft

The non-vascularized fibular strut graft was harvested from the intended donor site with a single longitudinal incision at lateral aspect of the leg. Using a periosteal elevator, the fibula was retrieved and measured about 6 cm avoiding damage to the surrounding neurovascular structure and tibiofibular joints. We preserved at least 7 cm of distal fibula to prevent ankle instability. Extra care given not to injure the common peroneal nerve supplying the extensor hallucis longus muscle. After harvesting the fibular graft, the distal part of the graft was fashioned to fit in at least 3 cm inside the distal humerus medullary canal (Fig. 2).

Fig 2: The fibular strut autograft is fashioned at the distal end of the graft to fit into medullary canal of the recipient proximal humerus.

Discussion

Four-part proximal humeral fracture with bone loss is a complex injury when it occurs in young patient. It is usually produced by high energy trauma. It poses certain difficulty to manage and is often associated with poor outcome. A wide variety of implants may be of choices for fixation of these fractures. Several surgical techniques include percutaneous Kirshner wiring, tension-band wiring, screws and plate fixation, intramedullary nail fixations and hemiarthroplasty have been performed for the last few decades [3]. Conventional plates alone arguably do not provide adequate stability due to poor bone stock and are prone to high rate of fixation failure. Various autografting techniques to improve bone union rates at the expense of patient's morbidity have been described in literatures. Badman and colleagues (2006) described an intramedullary bone peg technique whereupon corticocancellous graft harvested from the patient's iliac crest, anterior tibia or fibula to supplement fixation with rush rods or screws for long bone fracture [4]. The major complications associated with the harvest of proximal tibia bone graft, including deep hematoma formation, deep infection, joint perforation, donor site fracture, gait disturbance, and nerve injury, have been reported, with an incidence of 0.65 to 2.5% [5]. Some authors reported high incidence of persistent pain on the iliac crest postoperatively for patients whose graft haversted from iliac crest [6]. The use of nonvascularized fibular strut graft could be another option, and it has been proven to be reliable technique to reestablish bone continuity in segmental bone defect (Fig. 3). Fibula is probably the most suitable donor site for reconstruction of the defects in a long bone. This is judged from its length, geometrical shape and mechanical strength [7]. Fibula could be used to reduce the proximal humeral fracture, and at the same time, it acts as mechanical support for the humeral head [8].

In our case here, we use fibular autograft, of which we think is ideal because, aside from its osteoinductive and osteoconductive properties, it could bridge the medial bone stock gap [9]. For the plate of choice, we chose locking periarticular plate. Locking periarticular plates have become popular treatment option because of its advantages in comparison to other techniques [10]. However, Solberg and colleagues (2019) reported within 24 patients with proximal humerus fractures treated with locking plate alone, there were overall 79% complications, which consisted of 71% varus malalignment, 19% valgus malalignment, and the rest, screw perforation in the joint and subsidence [11]. Biomechanical testing showed that medial support with an intramedullary fibular graft and angular stable fixation increased the overall stiffness of the bone-implant construct and reduced migration of the humeral head fragment, as compared with the locking plate alone. This was also confirmed by Osterhoff and colleagues that those with fibular graft, after 400 cycles loading, intercyclic fragment motion, overall motion, and residual gap-distance deformation is significantly lower compared to conventional techniques [12]. In this case, screws purchase on cortical fibular strut enhances their pullout strength, which in turn provides higher stability and union rate for the patient. The fibular strut also acts as filler in the medullary cavity preventing abnormal movement. After 3 months follow-up, the shoulder radiograph showed no screws back out as well (Fig. 4).

Fig 3: Fibular strut graft was inserted inside the medullary canal of the recipient bone. It reestablishes bone continuity in segmental bone defect.

Fig 4: Ateroposterior radiograph of right shoulder at 3 months post-op showing proximal humeral interlocking system (PHILOS)

plating and fibular graft. The height of humeral head is intact.

Conclusion

Intramedullary fibular strut graft with a locking plate provides good mechanical stability for the proximal humeral fracture fixation. In addition to number of cortices purchased by screws, it also increases the pull-out strength of the screws and allows early range of motion exercises. We opt to choose locking plate with fibular strut graft augmentation as better alternative to hemiarthroplasty of the shoulder in young active adults with unstable comminuted proximal humerus fractures, particularly with poor bone stock or medial comminution.

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