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Original Research Article

A Comparative Study of Orthogonal Versus Parallel Plating for Distal Humeral Fractures

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ABSTRACT

Introduction: Fractures of the distal humerus are relatively common injuries, distal humerus fractures lead to significant burden on society due to its bimodal distribution with a peak in young males due to high energy trauma (road traffic accidents, fall from height, trauma to arm and gunshot wounds) and a other peak in older females usually by simple falls. There are several methods of fixation available, namely- plate fixation and external fixation. Out of which very commonly performed is plating.

Material and Methods: A total of 40 patients distal humerus fractures were treated with dual plating between May 2022 and May 2024. Of these, 20 patients underwent orthogonal plating (Group A), while 20 patients were treated with parallel plating (Group B). Patients were selected based on specific inclusion criteria: age between 18-60 years, fractures of the distal humerus with intra condylar extension, closed fractures, non-compliant patients for conservative treatment, polytrauma patients, and those who refused conservative treatment. Exclusion criteria included patients younger than 18 or older than 60 years, fractures involving the shaft of the humerus, previous humeral surgery, pathological fractures, open fractures, and nerve palsy. This prospective study utilized a sample size of 40 patients, with Group A consisting of odd-numbered patients receiving orthogonal plating and Group B consisting of even-numbered patients receiving parallel plating.

Results: Out of 20 operated cases of orthogonal plating, 18 patients had excellent, 2 patients had poor ASES score, whereas in parallel plating group 16 patients had excellent, 2 patients good, 2 patients poor American Shoulder and Elbow Surgeons (ASES) score, no post operative infections were noted, no non-union cases were noted, no significant difference in surgery time, blood loss, mean duration of hospital stay was noted.

Conclusion: Both orthogonal plating and parallel plating had similar outcomes with respect to elbow function and early physiotherapy. No significant difference in surgery time, blood loss, mean duration of hospital stay were noted.

Keywords: Parallel plating, Orthogonal plating, Distal humerus fracture

INTRODUCTION

Fractures of the distal humerus are common injuries accounting for approximately 3 percent of all fractures and 14 percent of all fractures of the humerus.[1] According to literature estimates, most common cause in young males is usually due to road traffic accidents (RTA), in older females is due to simple falls.[2]

Non-operative treatment is not successful in more than 60 percent of patients with distal humerus fractures.[2] Conservative methods, such as the above elbow slab, body bandage, prefabricated functional braces, and a simple sling,[1,2] are frequently utilized. Nonetheless, there are indications for surgical intervention, including inadequate alignment following closed reduction, multiple injuries, nerve palsy following manipulation, bilateral humeral fractures, segmental fractures, and open fractures.[3-6]

Complex fractures of the distal humerus cannot be effectively treated with single column plating systems, as these have been shown to be less stable under load compared to double column plating methods. Based on both clinical and biomechanical research, double plating is now the preferred fixation technique. Dual plating can be done in two configurations: an orthogonal setup (perpendicular, 90-90 plating), where one plate is placed on the medial column and the other on the posterolateral column, or a parallel setup, with one plate on the medial column and the other on the lateral column. Both ways of plating can be used for most distal humerus fractures.[7] External fixation is primarily reserved for open fractures or closed injuries with severe soft tissue compromise. Plate fixation provides stable fixation and excellent control of rotation, length, and angulation.[8] However, it is a technically demanding procedure that requires extensive exposure and soft tissue dissection, and carries a risk of infection, blood loss, and iatrogenic nerve injuries. Elective plate removal after bone union also poses a significant risk of nerve insult.[9-10]

MATERIAL AND METHODS

Orthogonal-Plating

The orthogonal plating technique involves placing two plates at 90-degree angles to each other, one on the medial column and the other on the posterolateral column. Various companies have developed their own implants for this technique, though they share similar features. This method was created to overcome the limitations of dual posterior plating, which often failed to provide adequate stability, leading to nonunion and stiffness due to prolonged immobilization. The AO group introduced the orthogonal plating system to ensure maximum stability and allow for early range-of-motion exercises. Their recommended approach includes using screws to fix the articular fragments and stabilizing the columns with two plates positioned at a 90-degree angle to one another.

Previous use of 3.5 mm reconstruction plates proved inadequate, particularly for osteoporotic patients, leading to the widespread adoption of locking pre-contoured plates. The posterolateral plate can be positioned as distally as the posterior edge of the capitellar articular surface. Posterior-to-anterior screw fixation offers better anchorage in the coronal fractured fragment of the capitellum. Meanwhile, the medial column plate should be placed along the sagittal plane on the supracondylar ridge, curving around the medial epicondyle (Figure-1).

Parallel-Plating

Parallel plating involves placing plates on the lateral and medial columns in a 180-degree, parallel alignment, unlike orthogonal plating. This method was developed to address the limitations of orthogonal plating, which was less effective in cases of osteoporotic or comminuted fractures, leading to issues like nonunion, metal failure, and stiffness. In parallel plating, the lateral plate is positioned along the supracondylar ridge in the sagittal plane, contoured distally in a "J" shape to fit the lateral epicondyle's angulation. The plates are slightly offset posteriorly, not directly medial or lateral. After initial fracture fixation, the plates are applied, and the screws are placed to secure the medial and lateral cortices.

The principle behind parallel plating is similar to architectural design, where two columns are anchored and connected at the top. The fixation relies on the stability of the hardware, not just the screw-bone interaction, adding strength to the "arch." Long screws in the distal fragments interlock and function as fixed-angle screws, enhancing fixation. According to Sanchez-Sotelo et al., the Mayo Clinic group highlighted the use of parallel plating to improve distal fragment fixation and provide stability at the supracondylar level.

Fig. 1. Intraoperative view of fixation using orthogonal plating. Note that the posterolateral column is fixed with a precontoured locking plate.

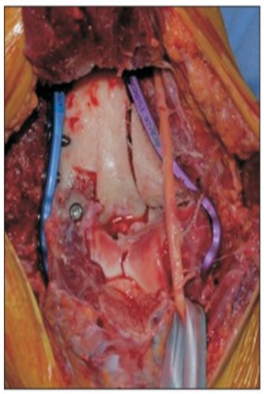


Fig. 2. Intraoperative view of fixation using parallel plating. Note that both plates are parallel and fixed along the medial and lateral column.

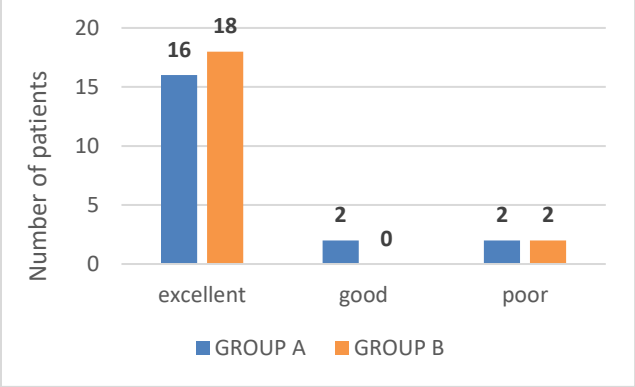
Clinical and radiological assessments were performed at 1.5, 3, 6, and 12 months to evaluate fracture healing. The ASES Elbow Score was employed for clinical assessment, while serial radiographs were used to monitor the immediate postoperative reduction and the progress of union. Fracture union was determined by the presence of bridging callus visible on at least three cortices, as seen in radiographic images.

The data was presented in tables, with continuous variables analyzed as means using the student's independent t-test. Categorical variables will be expressed as percentages and analyzed using the $\chi 2$ (Chi-square) test. Statistical analysis will be conducted using IBM SPSS Statistics 20, and a p-value of ≤ 0.05 will be considered statistically significant.

RESULTS

In our study, Group A (parallel plating) included 20 patients, with 12 aged between 18 and 30 years, 6 between

31 and 45 years, and 2 between 46 and 60 years. Group B (orthogonal plating) also consisted of 20 patients, with 15 in the 18-30 age group, 2 in the 31-45 age group, and 3 in the 46-60 age group. The majority of patients in both groups were male, and most had sustained their injuries from road traffic accidents (RTA). Additionally, the majority of fractures were on the right side. The mean duration of the procedure was 85±100.9 minutes in Group A and 95±100.9 minutes in Group B, with a p-value of 0.75, indicating no significant difference. The mean number of antibiotic doses administered was 6.23±11.95 in Group A and 6.76±11.95 in Group B, with a p-value of 0.75, showing no statistical significance. The mean duration of hospital stay was 4.6±7.18 days in Group A and 4.8±9.91 days in Group B, with a p-value of 0.94, suggesting no significant difference. Regarding Elbow function, in Group A (parallel plating), 14 patients had an excellent ASES score, 4 had a good score, and 2 had a poor score. In Group B (Orthogonal plating), 16 patients had an excellent ASES score, 2 had a good score, and 2 patients had a poor score with p value 0.7 showing no statistical difference (Graph-1).



Graph-1: Post-operative ASES Score

DISCUSSION

The surgical approach described involves a standard posterior technique, with or without olecranon osteotomy, emphasizing the careful handling of the ulnar nerve to prevent injury. During the procedure, the fracture is exposed, and provisional fixation using Kirschner wires (K-wires) and bone clamps is performed. Once the fracture is reduced, intraoperative imaging is used to confirm proper alignment before applying plates to the medial and lateral columns.[11]

For orthogonal plating, a plate is placed on the humerus' posterolateral surface, extending distally near the capitellum. The plate should have at least three screws above and below the fracture site for stability. The more stable column is fixed first, followed by the second plate. After securing the plates, range of motion is tested for stability and to ensure no mechanical block. If the approach involves triceps-related techniques, repairing the triceps is recommended.

In parallel plating, the lateral column requires more exposure. After proper exposure, articular fragments are temporarily reduced using K-wires. The plate length should allow for three screws above the fracture on both medial and lateral sides. Plates are temporarily held with K-wires, and after anatomical reduction is achieved, screws are inserted into the plates. After securing the distal fragments, attention is shifted to the supracondylar region, where interfragmentary compression is applied, followed by screw insertion to stabilize the fracture. The remaining screws for the humeral diaphysis are added for additional support.[12-13]

Postoperatively, patients wear an extension splint to minimize swelling and begin early motion exercises within a week. Consideration is given for prophylaxis of heterotopic ossification. Orthogonal plating is preferred for coronal fractures involving the capitellum and trochlea, while parallel plating is favored for lower-level or osteoporotic fractures, as it offers stronger fixation for smaller fragments. However, parallel plating can be technically challenging and poses a higher risk of soft tissue damage. Ultimately, the choice of technique depends on the specific fracture type and the surgeon's preference.[14]

CONCLUSION

Dual plating for distal humerus fractures is recommended for achieving stable fixation with improved surgical exposure and the use of newer implants. Biomechanical studies have shown little difference between orthogonal and parallel plating configurations, and neither technique has demonstrated a significant advantage in clinical outcomes. Both methods have produced satisfactory results, although each has its own set of complications.

The choice between orthogonal or parallel plating largely depends on the surgeon’s preference, Authors preference here is towards orthogonal plating because of the advantage due to increased stability and possible disadvantages of stress risers and nerve injury in parallel plating and factors such as fracture pattern and bone quality may also influence the decision. Successful treatment begins with a thorough understanding of the normal anatomy and fracture pattern prior to surgery. During the procedure, achieving an anatomic reduction of the articular surface, along with stable fixation that allows early range of motion and minimizes complications, is key to ensuring favorable outcomes.

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