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Modified application of distal medial tibial locking plate as an alternative for fixation of an extraarticular distal-third diaphyseal humerus fracture

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ABSTRACT

Introduction: Surgical management of Extraarticular Distal-third diaphyseal Humerus Fracture (EADHF) poses a dilemma in terms of surgical approach, implant selection and position of the implant due to the availability of various pre-contoured implants and plate configurations. Various studies have described a modified application of anatomic locking plates as a satisfactory method of fixation in the surgical management of EADHF.

Case presentation: This report discusses the modified application of anatomic Distal Medial Tibial locking Plate (DMTP) as an alternative strategy in fixation of an acute extraarticular distal-third diaphyseal fracture of the humerus in a 45-years-old female patient. Bony union was achieved successfully without any malalignment and the patient showed a full recovery with an excellent clinical and outcome at 2-years follow-up.

Conclusion: In EADHF, the use of 3.5 mm DMTP is advantageous as it offers rigid fixation by insertion of more number of 3.5 mm locking bicortical screws and stability in both columns. This promotes biological fracture healing, low rate of complication, early return to work with improvement in clinical function. Therefore, we recommend that pre-contoured 3.5 mm DMTP can be successfully used as an alternative fixation choice for the treatment of EADHF.

Introduction

An extraarticular distal-third diaphyseal humerus fracture (EADHF) is relatively rare in adults [1]. Management of acute EADHF is challenging owing to unique distal humerus anatomy, the close proximity of the elbow joint and a considerable lever arm with extensive deforming torsional forces acting on the shorter fracture fragment of the distal humerus [1,2]. Achieving satisfactory alignment and stability by conservative treatment with a hanging cast or functional bracing is not always feasible due to difficulty in controlling the rotation of the small distal fragment [2]. Moreover, the bone structure present in this meta-diaphyseal junctional area is relatively weak and demands a rigid stable fixation and early elbow mobilization to achieve a fracture union with satisfactory alignment and functional outcome [1,3].

The techniques for operative management of EADHF continue to evolve. However, implant selection for surgical treatment of EADHF remains a debatable topic, if not managed properly, can be debilitating for the patient in the long term with social and functional loss [3,4]. A variety of implants options are available such as intramedullary nail, plate osteosynthesis using dual-column

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plating, lambda plate, 3.5 and 4.5 mm locking compression plates, metaphyseal plate fixation and extra-articular distal humerus lateral column plate, each having its advantage and disadvantages [1–5].

This report describes an alternative method of fixation for EADHF using a modified application of 3.5 mm anatomic distal medial tibial locking plate (DMTP) through a posterior approach.

Case discussion

A 45-year-old, left hand dominant, obese female was brought to our Emergency Department following a motor vehicle accident complaining of pain over the left elbow. After an initial assessment, she was conscious, oriented and hemodynamically stable. On clinical examination, tenderness, abnormal mobility and bony crepitus were present at distal humerus level, however, found to be neurovascularly intact. She was otherwise fit and well without any comorbidities. Standard anteroposterior and lateral radiographs revealed a closed fracture of the distal-third diaphyseal humerus (AO-12B1) of the left side without any intra-articular involvement (Fig. 1). Considering the unstable fracture pattern, surgical intervention was planned and written informed consent was obtained from the patient after preoperative counselling.

Open reduction and internal fixation were done under general anaesthesia with the patient in the lateral decubitus position without using a tourniquet. Posterior triceps splitting approach was used to expose the fracture site and radial nerve. After exploration, the

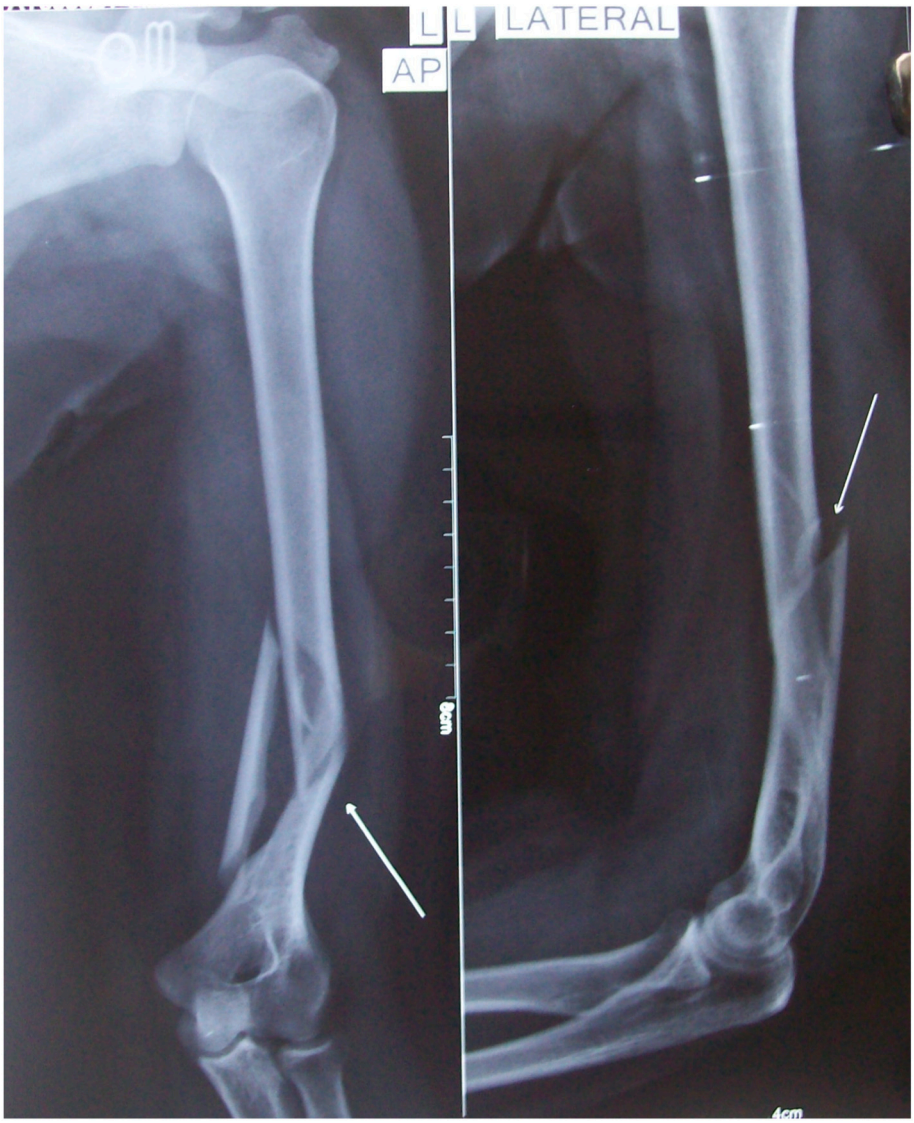

Fig. 1. Preoperative radiographs of a 40-year-male patient showing extra-articular distal-third diaphyseal fracture of left humerus (AO/OTA-12B1) without any intra-articular involvement.

butterfly fragment was reduced using a pointed bone holding forceps and fixed using a two 2.7 mm cortical screw. Taking into consideration the fracture pattern, it was not feasible to achieve 6 to 8 cortices purchase in the distal fragment using 4.5 mm dynamic compression plate (DCP). However, the available extraarticular distal humerus plate (EADHP) was not enough to achieve a stable rigid fixation in this obese patient and suggested the need for dual plating. The additional soft tissue stripping required for dual plating may result in devascularisation of the butterfly fragment. The next alternative available was Proximal Humeral Internal Locking System (PHILOS) plate as its contour appeared to match that of the posterior surface of the distal humerus, however, the direction of locking screw in the head of the plate pointing towards elbow joint was a concern due to possible risk of olecranon fossa impingement or intraarticular penetration.

Hence, following fracture reduction, an intraoperative decision was made to use a 11 hole 3.5 mm pre-contoured anatomic DMTP locking plate posteriorly. The plate was well fit around the contours of the posterior surface of the distal shaft humerus. The malleolar tip extension end of the plate was cut off and the plate was slightly bent before fixation to better fit the posterior surface of the distal humerus. Fixation was performed with insertion of eight 3.5 mm bicortical locking screws in the distal segment and six cortical screws

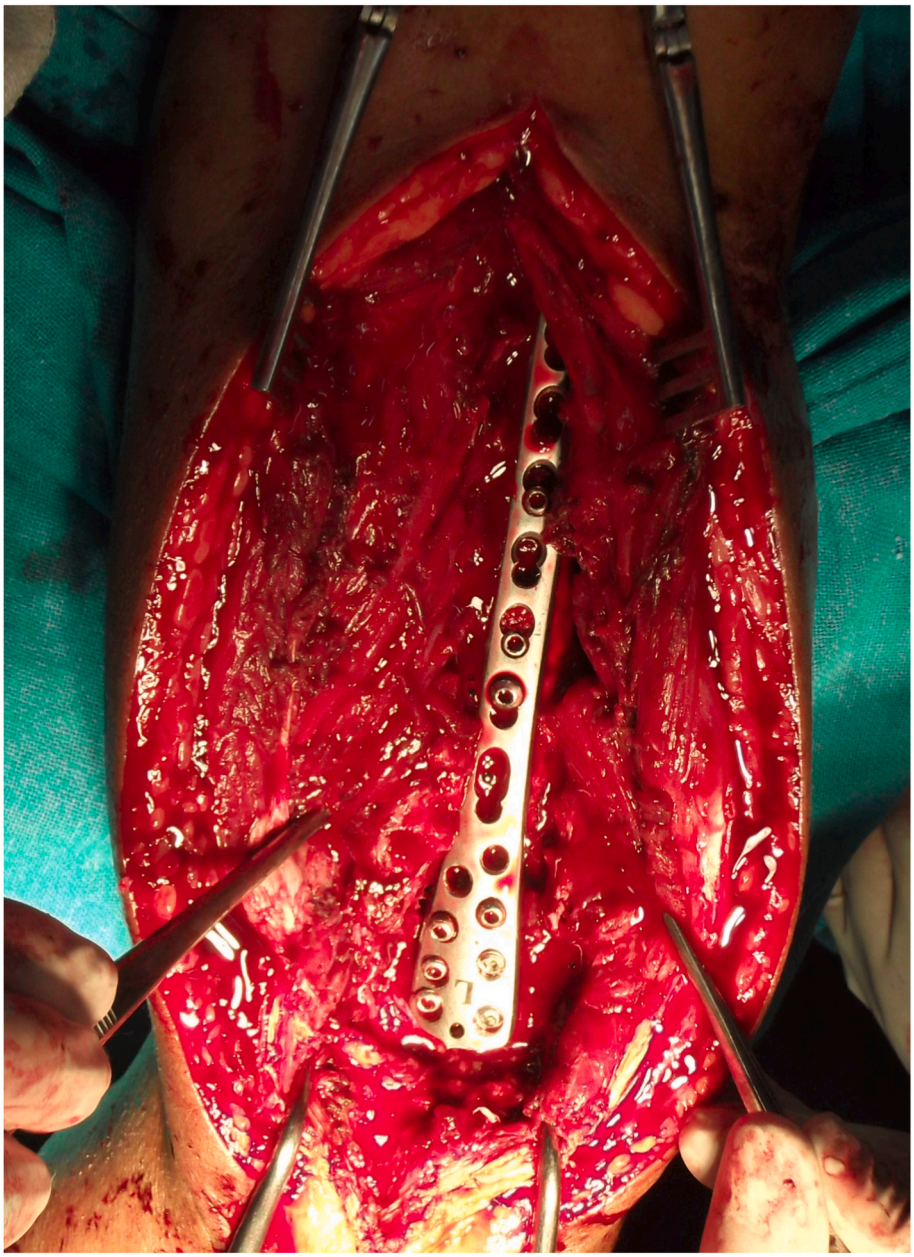

Fig. 2. Clinical photograph showing that the plate was well fit around the contours of the posterior surface of the distal shaft humerus after fixation without any impingement on the olecranon fossa.

in the proximal segment (Fig. 2). A rigid construct and stable fracture fixation were achieved, and there was no screw impinging on the olecranon fossa due to the screw configuration feature of the plate (Fig. 3). The surgical wound was closed in layers in regular fashion after triceps repair. No cast or slab was used for support.

Postoperatively, passive and active shoulder and elbow range of motion (ROM) exercises were started on the second day after pain control. The patient was discharged on 3rd postoperative day. Postoperative recovery was uneventful, except that the patient revisited the clinic after 4 days of discharge for worsening pain, however, on examination, the surgical wound appeared good without any signs of infection. Bony union was confirmed at 4-month follow-up and she regained full elbow function (Fig. 4). At 2-year follow-up, he had a stable elbow and excellent clinical outcome (Fig. 5) with a Mayo Elbow Performance Score (MEPS) of 100 and the Disabilities of the Arm, Shoulder and Hand (DASH) score of 2.5 with a stable elbow.

Discussion

Surgical treatment of EADHF using a single implant is challenging due to the rotational forces acting on the distal small fracture fragment [1,4]. Intramedullary nailing would not be an ideal choice in these cases considering the narrow medullary canal, reduced working length and shorter distal fracture fragment [5,6].

Owing to anatomic structure specific to the distal humerus, dual plate construct has shown to provide better biomechanical resistance as compared to single plating and is particularly useful in comminuted fractures with less cortical contact to prevent varus/valgus collapse and implant failure [1,3]. However, it is disadvantageous due to the need for extensive soft tissue dissection that seems

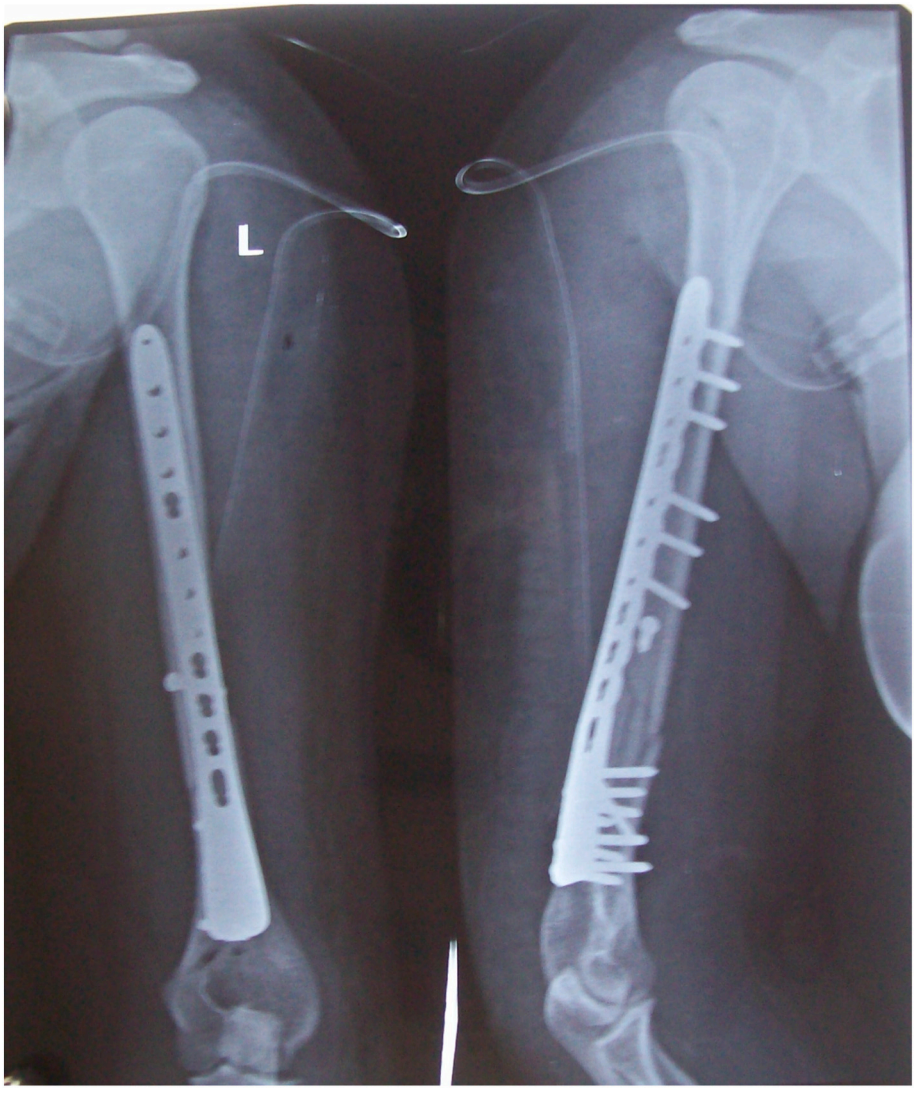

Fig. 3. Immediate postoperative radiographs after open reduction and internal fixation with a 3.5 mm DMTP locking plate showing satisfactory alignment.

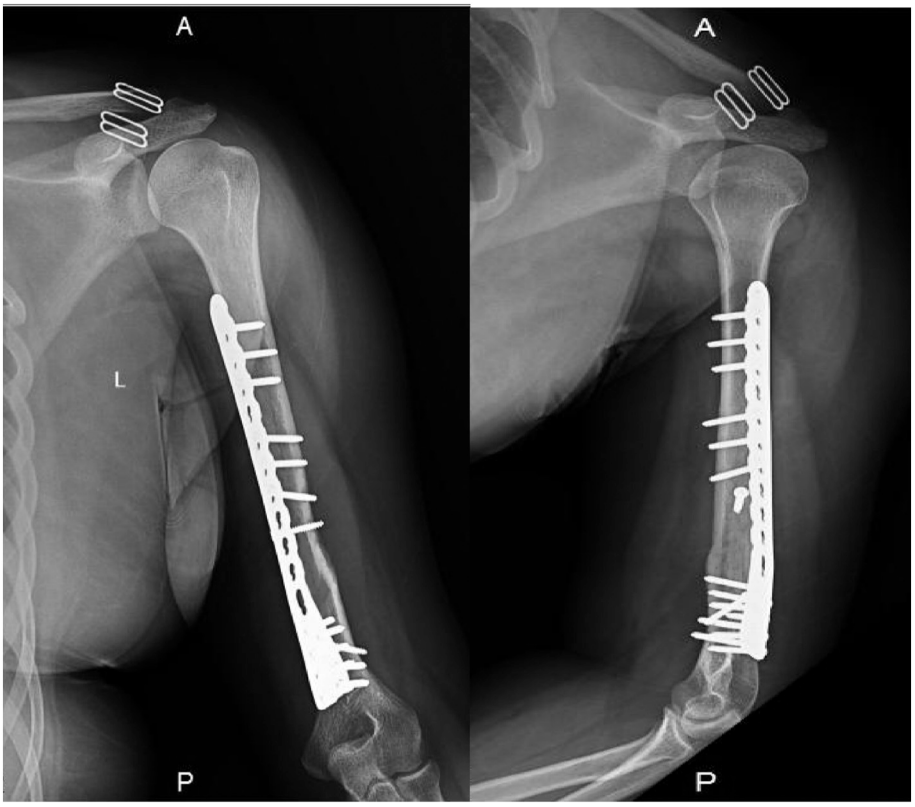

Fig. 4. Radiographs at 4-months follow-up showing complete bony union with satisfactory alignment.

Fig. 5. Clinical images of the patients at final follow-up showing excellent elbow function.

unacceptable for extraarticular fractures and is associated with complications such as stiffness, non-union, tardy ulnar neuropathy and hardware prominence [4,6].

Several authors have suggested centring the plate on the shaft, however, olecranon fossa impingement is the main concern while achieving adequate stability using a conventional plate of adequate length. Moran et al. addressed this issue using a narrow 4.5 mm DCP posteriorly along the lateral column at an angle of 5 to 8 degree off centre from the long axis of the humerus through an anterolateral approach [7]. Although, this improves stability by increasing purchase in the distal fragment but compromises fixation of the proximal fragment. Also, it is difficult to obtain 6–8 cortices purchase on either side of the fracture due to anteriorly curved distal humerus, restricted area for screw placement and olecranon fossa impingement when using plates of adequate length. Several cases of postoperative loss of fixation and poor results in osteoporotic patients using standard locking compression plates have been reported in

the literature and various implant failure mechanisms have been previously described [2,8].

To circumvent these issues, various modification of plate osteosynthesis have been previously described by many authors that include the use of modified lateral tibial head buttress plate, custom-made 'hybrid' locking plates, double reconstruction plates and anterior plating of the distal humerus [1,5,6,8,9]. Recently, an alternative choice of osteosynthesis is previously described by various authors that include modified use of 3.5 mm pre-contoured locking plates placed centrally on the shaft humerus, providing a flare extending distally for additional length and more distal screw for added fixation. Successful results have been reported with single plating technique using 3.5 mm precontoured plates in these fractures without olecranon fossa impingement [1,9,10,11].

We reviewed the literature and found only two studies that mention the use of 3.5 mm MDTP for fixation of EADHF. Parmaksızoglu et al. studied 23 patients with EADHF which were treated by the use of 3.5 mm MDTP and recommend that a stable fixation and union with satisfactory results can be achieved by anterolateral fixation of EADHF using 3.5 mm MDTP plate through a lateral approach [10]. Whereas, Yorukoglu et al. in their retrospective study described 18 EADHF patients treated surgically using 3.5 mm MDTP plate through posterior approach and suggest that a stable fixation with good functional results can be achieved using this plate [11]. To our knowledge, this is the first case report describing a modified application of 3.5 mm MDTP in the surgical management of EADHF through posterior triceps splitting approach. Single plating technique is less time consuming and requires less soft tissue stripping, thus promotes biological fracture healing [9–11].

The 3.5 mm anatomic pre-contoured MDLP locking plate used in our case was originally designed for complex intra and extra-articular distal tibia fractures [10,11]. The plate has eight 3.5 mm locking holes in the distal cobra shaped part which allows screw trajectory parallel to the joint line [10,11]. Therefore, we applied the cobra shaped head of the plate distally on the expanding posterior aspect of the distal humerus in EADHF that provide more secure fixation of the distal fragment by allowing placement of an adequate number of 3.5 mm locking bicortical screws and achieving stability in both columns. The large distal part of the plate seemed to fit the contours of the distal humerus and this construct provides more resistance against rotational forces which is the main reason for failure, particularly in conventional plates. A brief overview of the literature including previously published studies that described the modified application of pre-contoured plates in EADHF is discussed (Table 1).

Radial nerve palsy in extraarticular distal humerus fractures is associated preoperatively in up to 23.6% patients and in up to 57% patients who were treated surgically [12]. The posterior approach allows for exploration of radial nerve, and repair if needed during the same surgical procedure. The reported reoperation rate in surgically managed patients is up to 20% that can be due to various reasons such as infection, non-union, iatrogenic nerve palsy [2,13]. Therefore, the patient should be counselled preoperatively regarding the radial nerve palsy and the possible need for reoperation. Prasarn et al. reported successful union in all of their patients, however, the demineralised bone matrix was used in 10 out of 15 patients to achieve union along with dual plating [3]. The successful bony union achieved in our study without the need for bone graft suggest that the single pre-contoured anatomic MDTP locking plate is sufficient to allow a stable rigid fixation that allows early elbow ROM and recovery with good functional results.

We believe that this technique can be used alternative fixation method for management of EADHF as it promotes biological healing and early elbow ROM, thus reduces overall complications rate and improves clinical function.

Conclusion

The reduced surgical time and less soft tissue stripping associated with the use of a 3.5 mm MDTP in fixation of EADHF promotes biological healing and reduces complication rate, thus enables a stable rigid fixation without olecranon fossa impingement allowing early recovery and return to work. Therefore, can be considered a fixation of choice in the management of EADHF.

Consent

Written informed consent was obtained from the patient for his anonymized information to be published in this case report.

Clinical message

We recommend posterior fixation using a 3.5 mm distal medial tibia locking plate (DMTP) as a choice of fixation in the management of EADHF for biological healing and successful outcome.

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None.

CRediT authorship contribution statement

Dr. Babaji Thorat: Conceptualization, Writing – Original Draft, Resources, Methodology, Data Curation
Dr. Avtar Singh: Conceptualization, Review & Editing
Dr. Rajeev Vohra: Supervision, Formal analysis, Writing - review & editing
Dr. Mohammad Arshad: Data Curation, Writing - review & editing
Dr. Ravi Mavani: Data Curation, Investigation

Table 1
A brief overview of the literature comparing the results of the modified application of pre-contoured plates in EADHF from previous studies.

Study	Sample Size and demographics	Surgical approach and Implant Used	Union	Clinical outcome	Fracture characteristics	Comment	Complications
Levy et al. 2005. [8]	15 Mean follow up- 5 months.	Single plate; Posterior approach; 4.5 mm modified Lateral Tibial Head Buttress Plate.	Union was achieved in all patient.	Average elbow ROM was 11–112 degrees.	12 acute fracture and 3 non-union cases	Recommend fixation with modified Lateral Tibial Head Buttress Plate; provides additional length and more distal screw holes without olecranon fossa impingement,	Postoperative infection with osteomyelitis in one patient; intravenous antibiotics
Parmaksızoglu et al. 2016. [10]	23 (17 Male: 6 Female). Average age-34 years. Mean follow up- 16 months	Single plate; Lateral approach; Medial distal tibia locking plate 2.7/3.5 mm	All united. Mean union time- 19.3 weeks.	Mean flexion-135, mean MEPS-100, mean DASH score-12.7. Mean VAS-0.5.	All were acute fractures.	Recommend anterolateral fixation using anatomical locked plate through lateral approach; avoids iatrogenic triceps muscle and radial nerve injury.	None.
Yorukoglu et al. 2018. [11]	18 (11 Male: 7 Female). Average age- 37 years. Mean follow up-36.2 months.	Single plate; Posterior approach; 3.5 mm DMTP anatomic locking plate.	Union was achieved in 17 of 18 patients. Mean union time- 7.8 months.	Mean MEPS-84.4. Mean DASH-T- 27.1. VAS at rest and activity was 1.8 and 4.5 respectively.	15 acute fracture and 3 non-union revision cases.	Recommend DMTP as a fixation choice; allows radial nerve exploration, high rates for union, low rates for complication, and early return to work with early rehabilitation.	One patient had infected non-union and treated by debridement and implant revision.
Sohn et al. 2019. [9]	23 (18 Male: 5 Female). Average age-41.9 years. Mean follow up- 18.1 months.	Single plate; Anterior approach; Upside down application of 3.5 PHILOS plate.	All united. Mean union time- 20.8 weeks.	Mean elbow ROM was 3.3–130.4 degrees. Average MEPS-97.6.	All were acute fracture.	Upside-down application of the PHILOS plate can be an alternative method for fixation; increase plate-screw density with bicortical locking screw fixations, avoids triceps injury.	None. However, implant removed in 3 patients upon request.

DASH score: Disabilities of the Arm, Shoulder and Hand score, DMTP: Distal Medial Tibia locking Plate, MEPS: Mayo Elbow Performance Score, PHILOS: Proximal Humeral Internal Locking System, ROM: Range of Motion, VAS: Visual Analogue Scale.

Declaration of competing interest

The authors declare that our manuscript is an original publication and the data is case report is real. The authors report no conflicts of interest.

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