Egyptian Journal of Orthopaedic Research "*EJOR*"
An international peer-reviewed journal published bi-annually

Volume 4, Issue 2, Dec. - 2023: pp: 45-52 www.ejor.sohag-univ.edu.eg
Doi: 10.21608/ejor.2023.346401

Original Article

PROSPECTIVE STUDY OF THE MANAGEMENT OF DISTAL ULNA FRACTURES USING HOOK PLATE IN ADULT

Ahmed Saleh Shaker Sleem[1], Abdelrahman Hafez Khalifa[1(*)], Mohamed Fathy Tawfeek Saleh[2], & Ashraf Rashad Ahmed Marzouk[1].

[1]*Orthopedics and Traumatology dept., Faculty of Medicine, Sohag Univ., Sohag, Egypt*
[2]*Orthopedics and Traumatology, Sohag University Hospital, Sohag, Egypt*

E-mail: dr.abdelrahman_alshikh@yahoo.com

Received 22/4/2023 Accepted 28/10/2023

Abstract

Background: *Once the distal radius fracture has been corrected and stabilised, the majority of distal ulna fractures are properly aligned and stable. Dennison et al. first developed the locked plate fixation method for managing distal ulna fractures, and it was successful. The distal ulna hook plate is a contoured anatomical plate that fits the distal ulna.* ***Patients and methods:*** *This prospective work was performed on 20 individuals presented to Orthopedic and Traumatology Department, Sohag University hospital, with distal ulna fractures, to evaluate the results of the distal ulnar plate in the management of adult distal ulna fractures.* ***Results:*** *Patients in this research ranged in age from 28 to 53, with a mean age of 39.9± 9.4 years. The individuals in the current research had a mean range of motion of 20.5± 5.9, which ranged from 10 to 25. The mean adjusted Mayo wrist score, which ranged from 50 to 100, was 88± 16. 60% of individuals had outstanding Mayo scores, 30% received good Mayo scores, and 10% received poor Mayo scores.* ***Conclusion:*** *The anatomical distal ulna hook plate is designed to accommodate the distal ulna. The positive results of this research indicate that basal oblique ulnar styloid fractures and intra-articular ulna head or neck fractures may both benefit from intervention with the distal ulna hook plate. All DUFs had excellent functional outcomes, involving broad wrist ROM and high satisfaction among patients. It is important to let patients know that residual pain is frequent. counselling for patients is crucial.*

Keywords: *Distal, Ulna, Hook, Plate*

1. Introduction

The distal ulna is an integral part of forearm and wrist movement. Since, a more accurate concept considers the three-forearm radio-ulnar joints (distal, middle, and proximal) as a single unit "forearm joint" because the forearm allows for supination/pronation and longitudinal transfer of load, these joints must cooperate to give stability and motion [1]. Radius and ulnar' head and neck of fractures in the distal forearm have a usual distribution of ages, peaking in youth (5-14 years) and then again in the older individuals (65-85 years). In younger individuals, it is a fairly uncommon injury since the majority of their cases are brought on by high energy trauma that results in comminuted fractures and is commonly accompanied by related soft tissue harm, such as car accidents [2]. Forearm fractures are frequently the most prevalent reason why kids and teenagers seek orthopaedic care. Since the increased usage of

trampolines in Finland has been linked to an increase in forearm fractures among youngsters [3]. Majority of these cases are low or moderate energy injuries that used to be treated by cast immobilisation and closed reductions. But in last years, the surgical intervention has been increasing for children treatment, particularly flexible intramedullary nail fixing [3]. The majority of distal ulnar fractures happened in association with a distal radius fracture. Within fractures of the distal forearm, the ulnar styloid fracture is the most prevalent, and this injury has received a lot of attention in the literature showing that fracture within the ulnar styloid having stable distal radioulnar joint (DRUJ) does not require distinct surgery. However, the distal ulna can fracture at the level of the ulnar metaphysis or the distal shaft that is less frequent and have no much data about its proper management [4]. adequate fixation of fractures is exacerbated by multi-fragmentary patterns of fractures and rupture of the distal radioulnar joint (DRUJ). Pronation-supination is a challenging motion which involves axial and horizontal translation with radius rotation surrounding the ulna [5]. This study's objective is to evaluate the results of employing a distal ulnar plate to repair distal ulna fractures in adult patients.

2. Patients and Methods

This single-center, observational work was conducted as a prospective clinical trial on 20 individuals with distal ulna fractures presented to the Orthopedic and Traumatology Department, Sohag Univ. Hospital, in the period from April 2021 till April 2022 after approval from the medical research ethics committee.

2.1. *Inclusion criteria*

1. Intra-articular distal ulnar fractures.
2. Extra-articular fracture of the distal ulna.
3. Ulnar head or neck fractures with an angulation of greater than 10 degrees, whether stable or unstable.
4. Fractures of the ulnar styloid process.
5. Skeletal maturation.

2.2. *Exclusion criteria*

1- Pathological fractures.
2- Skeletally immaturity.
3- Neurovascular problems.

2.3. *Preoperative assessment*

- **History taking:** Including demographic data (age and gender), (hypertension, diabetes mellitus, cardiovascular conditions, and chronic kidney disease or chronic liver disease) are examples of co-morbid illnesses, medications and smoking status**.**
- **Routine laboratory investigations:** Including a complete blood count, tests for the kidneys and liver, a coagulation profile, an electrocardiogram, a chest X-ray, and fasting blood sugar.
- **Imaging:** For the purpose of preoperative evaluation and fractures categorization, lateral and PA views of the injured wrist joint and distal ulna were obtained for each individual. The fracture patterns were categorised based on the X-rays in accordance with the AO Comprehensive Classification of Fracture Distal Ulna (Q Modifier Classification). The included fractures' initial radiographs were categorized using the 2018 AO/OTA classification [6].

2.4. *Surgical technique*

20 individuals with a distal ulnar fracture underwent open reduction along with internal fixation with the distal ulnar locking compressing hook plate (titan-ium 2.4 mm hooked distal ulnar locked plate). The impacted limb was draped under general anesthesia, and a direct approach to the distal ulnar shaft was performed utilising a 6-8 cm longitudinal medial incision starting at the tip of the ulnar styloid and continuing proximally on the ulnar shaft. The deep fascia was then cut across the same line as the skin incisions, and the dorsal sensory branches of the ulnar nerve was determined and cautiously safeguarded. To display the ulna subperiosteally, a sharp incision is made between the extensor and flexor carpi

ulnaris (ECU and FCU). A bare space occurs between the tendons of the ECU and FCU, making full exposing of the ulnar head undesirable since it will separate important soft-tissue stabilisers. The best location to apply the low-profile plate is in this bare region that extends towards the ulnar styloid. The fixation is then accomplished using a titanium 2.4 mm hooked distal ulnar' locking plate that is anatomic precontoured, has a low-external profile, and has smooth, rounded edges that minimise irritation to soft tissues. Following fractures exposing, reduction is performed, and Kirschner wires (K-wires) might be employed, if required, to temporarily stabilise the reduction. The hooks are initially attached on the ulnar styloid' tip before the plate is centred prox. upon the shaft of the ulna. The plate is then put over the earlier prepared surfaces. The simplest way to do this is to insert a drill guiding to one of the proximal locking holes and use it as a handle before beginning to fixate the fractures with distal screws in the ulnar head. In order to modify the length of the shaft, a 2.4 mm non-locking self-tapping screws is placed in the centre of the oblong hole, then tightened following the desired length has been reached. A lag screw of 1.5 or 1.3 mm may be inserted in the space between the distal hooks' arms to stabilise un-stable fractures at the ulnar styloid' base. ORIF is carried out following ulna fixation in situations with distal radius fractures. Following fixation, the DRUJ's mobility and stability are clinically evaluated, followed by appropriate homeostasis, skin closure, and the application of a below-elbow slab for four-week period. Every individual will get an above-elbow splint after surgery to allow for finger mobility. After the stitches are removed, the splint is replaced with a detachable one two weeks later. Follow-up appointments are then scheduled for three and six months after surgery.

2.5. *Postoperative evaluation*

1. Postoperative radiography (lateral and PA X-rays) was taken to evaluate fractures reduction, and appointments to place the plate were made for 2 weeks, 1-, 3-, and 6-months following surgery, as required, until the final follow-up to evaluate union.
2. Alignment was evaluated by measuring the angulation of the ulnar metaphysis on posteroanterior radiography with anatomic positions (coronal plane) and lateral radiography with 90° pronation (sagittal plane), in addition to evaluating ulnar variance.
3. Wrist range of motion (ROM), the modified Mayo wrist score, the Visual Analogue Scale [VAS], and the Satisfaction Score were used to assess wrist functioning.
4. A goniometer was used to assess the wrist's and forearm's ROM (extension, flexion, supination, and pronation).

2.6. *Statistical analysis*

The SPSS programme version 26 (Statistical software for Social Science) was utilized to computerize and statistically analyse the data that had been gathered. Utilising the Shapiro Walk test, the distribution of the data was checked for normality. Frequencies and relative percentages were used for displaying qualitative data. Mean and standard deviation were used for displaying quantitative information. Level of P-value < 0.05 indicates significant while, $P \geq 0.05$ indicates non-significant difference.

3. Results

This research had a sample of twenty individuals in total. The age ranged from 28 to 53 years, with the mean age being 39.9 ± 9.4 years. Follow-up data for 6 months included 20% fem-ales and 80% male tab. (1). There were 70% of the participants had affected right side and 30% left side, fig. (1). The mechanism of injury was investigated among the participants. Among our participants, there were 70% had distal ulnar fracture

from assault and 30% from fall from height, fig. (2). The mean range of motion was 20.5± 5.9 and ranging from 10 to 25, fig. (3). The mean pain score was 22± 3.5 and ranging from 15 to 25, fig. (4). The mean satisfaction score was 21.5± 4.7 and ranging from 10 to 25, fig. (5). The mean modified Mayo wrist score was 88± 16 ranging from 50 to 100. There were 60% of the participants had excellent Mayo score, 30% of the participants had good Mayo score, no one had fair Mayo score, and 10% had poor Mayo score, fig. (6).

Table (1) Sociodemographic data of the participants

Variable		N= 10
Age (years)	Mean ± SD	39.9± 9.4
	Median (range)	41 (28, 53)
Gender	Female, n (%)	4 (20)
	Male, n (%)	16 (80)

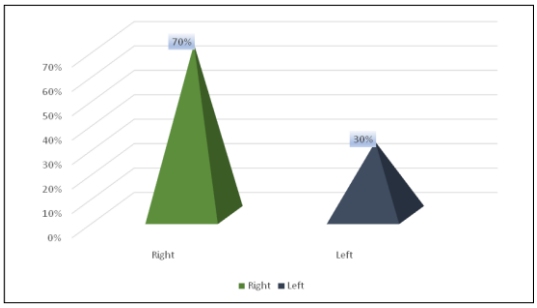

Figure (1) Affected side among the participants

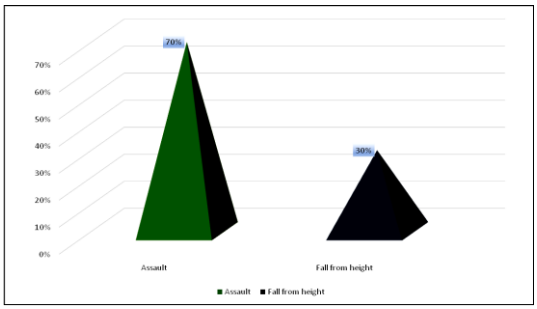

Figure (2) Mechanism of injury among the participants

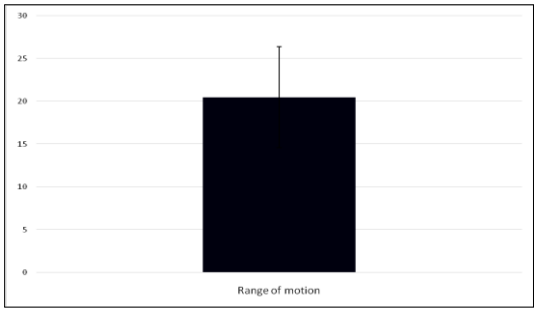

Figure (3) Mean range of motion among the participants

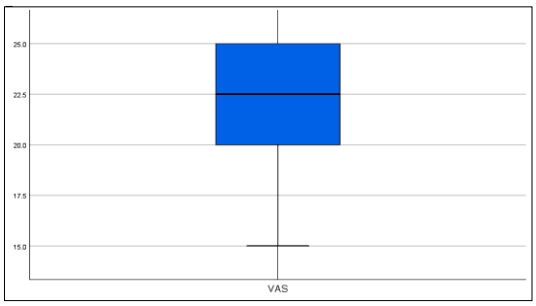

Figure (4) VAS score among the participants

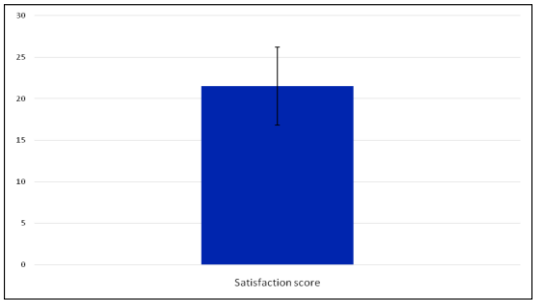

Figure (5) Satisfaction score among the part-cipants

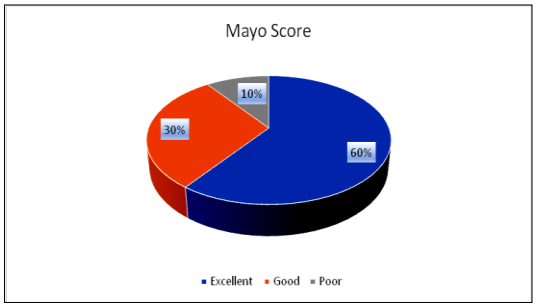

Figure (6) Mayo score among the participants

4. Discussion

Once the distal radius fracture has been corrected and stabilised, the majority of distal ulnar fractures which are linked to the distal radius fractures are perfectly aligned and stabilised. Open reduction and surgical stabilization are necessary for unstable and displaced fractures, and a mini-fragment plate is often used to prevent damage to the load-bearing surfaces [7]. The recommended uses for the plate have recently been expanded to include the management of distal ulnar non-union, particularly ulnar styloid non-union, improving secure in osteopenic bone, despite the fact that it was originally developed for distal ulna fractures [8]. In order to evaluate the effectiveness of utilising a distal ulnar plate in the management of distal ulnar fractures in

adults, prospective research was performed on twenty individuals who had distal ulna fractures and were admitted to the orthopaedic and traumatology department of the Sohag Univ. Hospitals. Patients in this research ranging in ages from 28 to 53 years, their mean age of 39.9 ±9.4 years. 80 % of them were men. 70% of the subjects suffered fractures on their right side. When the participants' injury mechanisms were examined, it was discovered that 30% of them had fallen from a height, and 70% had been assaulted, resulting in a distal ulnar fracture. Similar to other studies Saikia et al. [9], who stated a mean age group of 30.5 years, Matejcic et al. [10] (43 years), and Frankie et al. [11]. this study found a prevalent fractures incidence in the middle age group (between 28 and 53 years). To assess the effectiveness of the Locking Compression Distal Ulnar Hook Plate (LCDUP) in treating individuals who have distal ulnar fractures (either alone or coupled with distal radius fractures), Bakouri et al. [12] undertook research. The patient's mean age (35.9 ±9.7 years, ranging from 22 to 58 years) was equivalent to that of this research. Males made up 55.6% of the study group while females made up 44.4%. Open reduction internal fixation (ORIF) and conservative therapies for distal ulnar fractures (D UF) related to distal radius fractures (DRF) have been contrasted by Cha et al. [13] in this study. His study's overall mean age was 67.5 years, which was higher than average for the patients' age group. According to the findings of the dominance of a participating extremity, the dominant extremities was more engaged than the non-dominant one. This might be because people often utilise their dominant limbs to defend themselves during attacks, and they may also land with their dominant hand first when they fall. The individuals in the current research had a mean range of motion of 20.5±5.9, which ranged from 10 to 25. An evaluation of the functional and clinical results after LCP distal ulna plate fixing of unstable or irreducible distal ulna fractures with concurrent distal radius fractures was done by Han et al. [14] in their research. The average range of extension, flexion, deviation of radius, deviation of ulna, pronation, and supination was 72 degrees, 75 degrees, 22 degrees, 36 degrees, 85 degrees, and 78 degrees, correspondingly. In retrospective research by Lee et al. [15], each participant had satisfactory wrist range of motion (ROM) after distal ulnar hook plate stabilisation for the management of an un-stable distal ulnar fractures coupled with a distal radial fracture. The mean pain score in this research was 22 ±3.5, with a range of 15 to 25. Between 10 and 25, the mean satisfaction score was 21.5 ±4.7. In the research by Spiteri et al. [16], individuals who had far-distal AO-23B3 and AO-23C3 fractures received therapy in a tertiary hand centre utilising a Variable-Angle Distal Radius Volar Rim Plate. The visual analogue scores for patient therapy satisfaction and pain severity revealed favourable treatment satisfaction and mild intermittent pain on exertion. The outcomes of a work by Vishwanath et al. [17] on 53 individuals who had diaphyseal fractures of the forearm and underwent therapy with a limited contact dynamically compressing plate showed that excellent functional outcomes were achieved in 40 individuals (80%), satisfactory results in five patients (10%), and fair to poor results in the remainder of the participants. The average modified Mayo wrist score, which ranged from 50 to 100, was 88±16. 60% of individuals had outstanding Mayo scores, 30% received good Mayo scores, none received fair Mayo scores, and 10% received poor Mayo scores. This is reinforced by the findings of the Bakouri et al. [12] research, in which participants with distal ulnar fractures who received locked com-pressing distal ulna hook

plates had a modified MAYO score of 90.5± 14.6 ranging from 52 to 100. The majority of the study group (77.8%) had out-standing functional results, 11.1% had good results, and 11.1% had satisfactory outcomes. The Mayo score was calculated during research on individuals managed for un-stable distal ulnar fractures using titanium 2 mm hooked distal ulnar locking plates, and the results showed a mean Mayo score of 83.5, with excellent individuals making up 75% of the sample, good patients 5% of the sample, and satisfactory pat-ients the remaining 10%.18 individuals with either an AO: 2R3B3 or a C3 fracture with a VMF received surgical correction using a volar technique for the research by Gavaskar et al. [18,19]. A volar hook plate with anatomical contours was used to stabilise the VMF. Utilising 2.4/2.0 mm locking plates, the remainder of the fracture components were stabilised. 75 ±5.3 was the average Mayo wrist score. The average postoperative modified Mayo wrist score (ranging, 65-100 points) in a retrospective, work to assess the results of distal ulnar hook fixing with plates for the management of an unstable distal ulnar fractures accompanied with a fracture of the distal radius was 87 points [15]. LCP distal ulna hook fixing plate was recently discovered to have a quick recovery period, enhanced functional performance, and the capacity to resume early motions. Wide wrist range of motion and the absence of DRUJ instability were determined to be gra-tifying functional results, although the prevalence of delayed union was quite low. The distal ulnar fractures configuration, abundant cortical bone, comminution, individual age, and stability may all impact how quickly the DUF heals. Since inadequate stability or significant sub-periosteal dissection were detected during the operation, the surgical therapy may have an adverse effect on bone repair [12]. Because the study's unsuccessful patients had these risk factors, it was assumed that only age (over 50 years old), smoking, and diabetes mellitus characteristics may have a negative impact on bone repair [12]. It was also noted that ulnar shortening osteotomies in individuals with diabetes took longer to heal than non-diabetics because of peripheral vascular effects that diminished blood supply to the fracture area, increased osteoclastic activity at the fracture site, and decreased osteoblast production, all of which impact the healing process of fractures and raise the risk of complications. Smoking has similar impacts because nicotine is a potent vasoconstrictor [15]. However, there are some drawbacks to the Hook plate placement approach. For example, if the fracture involves the intraarticular neck or head part, it may be challenging to fixate and restore these plates since there is not sufficient articular surface accessible for the fixation [15]. For intra-articular fractures such as (ulnar head or neck fractures), in addition, ulnar styloid fractures in basal oblique pattern, the implementation of the distal ulnar hook plate may be an appropriate substitute therapeutic approach. All DUFs had positive functional outcomes, including broad wrist range of motion and no DRUJ instability. For senior patients, a strategy that includes fixing for DRFs and non-intervention for DUFs is a suitable choice [12]. However, there is a risk of morbidity associated with percutaneous K-wire operations because of pin-site itchiness, migration, infections, or loosening. However, they only have a few indications for use in osteoporotic or comminuted bone, necessitating surgical immobilisation [15]. A more severe limitation of forearm mobility will occur in the event that the distal ulna does not recover in its normal position anatomically, involves separation of the DRUJ along a trans-verse axis and substantial chronic ang-ulation at the place of fracture site [5].

Case 1

Figure (7) A preoperative x-ray A/P and lat. view of a wrist joint with fracture distal ulna.

Figure (8) Showing a postoperative x-ray A/P and lat. view of a wrist joint with fracture distal ulna, after reduction with distal ulna hook plate

Figure (9) One-month postoperative x-ray A/P and lat. view of n wrist joint with fracture distal ulna, after reduct-ion with distal ulna hook plate

Figure (10) Three months postoperative x-ray A/P and lat. view of a wrist joint with fracture distal ulna, after red-uction with distal ulna hook plate

Figure (11) Six months postoperative x-ray A/P and lat. view of a wrist joint with fracture distal ulna, after reduction with distal ulna hook plate.

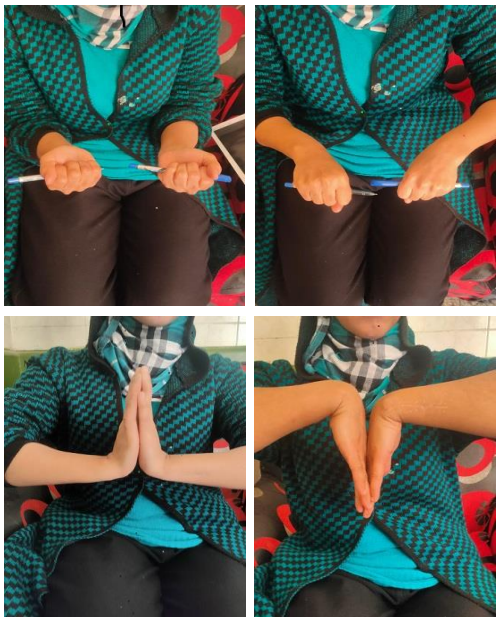

Figure (12) Range of motion

5. Conclusion

The anatomical distal ulnar hook plate is designed to accommodate the distal ulna. The positive results of this research indicate that basal oblique ulnar styloid fractures and intra-articular ulnar head or neck fractures may both benefit from intervention with the distal ulna hook plate. All DUFs had excellent fun-ctional outcomes, involving broad wrist ROM and high satisfaction among patients. It is important to let patients know that residual pain is frequent. counselling for patients is crucial.

References

[1] Dumontier, C. & Soubeyrand, M. (2014). The forearm joint, In: Bentley, G. (eds.) ***European Surgical Orthopaedics and Traumatology***. Springer, Berlin: 181-194.

[2] Gschwentner, M., Arora, R., Wambacher, M., et al. (2008). Distal forearm fracture in the adult: Is ORIF of the radius and closed red-uction of the ulna a treatment option in distal forearm fracture?. ***Arch Orthop Trauma Surg***. 128 (8): 847-855.

[3] Shaerf, D., Chae, W., Sharif-Razavian, R., et al. (2020). Do "Anatomic" distal ulna plating systems fit the distal ulna without causing soft tissue impingement?. ***Hand***. 17 (3): 506-511.

[4] Lutsky, K., Lucentim, L. & Beredjiklian, P. (2020). Outcomes of distal ulna fractures associated with operatively treated distal radius fractures. ***Hand***. 15 (3): 418-421.

[5] Kang, H., Shim, D., Yong, S., et al. (2002). Operative treatment for isolated distal ulnar shaft fracture. ***Yonsei Med J***. 43 (5): 631-636.

[6] Meinberg, E., Agel,. J, Roberts, C., et al. (2018). Fracture and dislocation classification compendium-2018. ***J Orthop Trauma***. 32 (Suppl 1): S1-S170.

[7] Moloney, M., Farnebo, S. & Adolfsson, L. (2020). Incidence of distal ulna fractures in a Swedish county: 74/100,000 person-years, most of them treated non-operatively. ***Acta Orthop***. 91: 104-108.

[8] Kim, J-B., Song, I-S., Park, B-S., et al. (2017). Comparison of the outcomes between headless cannulated screw fixation and fixation using a locking compression distal ulna hook plate in fracture of fifth metatarsal base. ***J. Foot Ankle Surg***. 56: 713-717.

[9] Saikia, K., Bhuyan, S., Bhattacharya, T., et al. (2011). Internal fixation of fractures of both bones forearm: Comparison of locked compression and limited contact dynamic compression plate. ***Indian J. Orthop***. 45: 417-421.

[10] Matejcic, A., Ivica, M., Tomljenovic, M. et al. (2000). Forearm shaft fractures: Results of ten-year follow-up. ***Acta Clin. Croat***. 39: 147-154.

[11] Frankie, L. & Chow, S-P. (2003). A prospective, randomized trial comparing the LC-DCP with the point contact fixator for forearm fractures. ***JBJS***. 85: 2343-2348.

[12] Bakouri, M., El-Soufy, M., El-Hewala, T. et al. (2021). Fixation of distal ulna fractures by distal ulnar Locked Hook Plate. ***Egypt. J. Hosp. Med.*** 82: 506-513.

[13] Cha, S-M., Shin, H-D., Kim, K.-C., et al. (2012). Treatment of unstable distal ulna fractures associated with distal radius fractures in patients 65 years and older. ***J. Hand Surg. Am***. 37: 2481-2487.

[14] Han, S., Hong, I. & Kim, W. (2014). LCP distal ulna plate fixation of irreducible or unstable distal ulna fractures associated with distal radius fracture. ***Eur. J. Orthop. Surg. Traumatol***. 24: 1407-1413.

[15] Lee, S., Kim, K., Park, J. et al. (2012). Distal ulna hook plate fixation for unstable distal ulna fracture associated with distal radius fracture. ***Orthopedics***. 35: e1358-e1364.

[16] Spiteri, M., Ng, W., Matthews, J. et al. (2017). Functional outcome of fixation of complex intra-articular distal radius fractures with a variable-angle distal radius volar rim plate. ***J. Hand Microsurg***. 9: 11-16.

[17] Vishwanath, C., Satheesh, G., Dwiv-edi, S. et al. (2017). Surgical management of fracture both bones forearm in adults using LC-DCP. ***Int. J. Orthop***. 3: 97-108.

[18] Tabl, E. (2015). Preliminary outcomes of hooked locked plate in management of unstable distal ulna fractures. ***AL-Azhar Assiut Med. J***. 13: 283-290.

[19] Gavaskar, A., Parthasarathy, S., Balamurugan J. et al. (2021). Volar hook plate stabilization of volar marginal fragments in intra-articular distal radius fractures. ***Injury***. 52: 85-89.