Int J Burn Trauma 2023;13(3):142-148
www.IJBT.org /ISSN:2160-2026/IJBT0148103

Original Article

The impact of COVID-19 lockdown on the clinical and radiological outcomes of both-bone forearm fractures treated by compression plating at a tertiary care centre in India: a retrospective study

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Received November 29, 2022; Accepted May 17, 2023; Epub June 15, 2023; Published June 30, 2023

Abstract: Background: The COVID-19 pandemic has affected everyone's life. In India, the nationwide lockdown was enforced from March 25, 2020. It has significantly affected the healthcare delivery system. Both-bone forearm (BBFA) fractures are commonly encountered as an emergency. Surgical management with plate fixation is often the primary mode of management in adults and adolescents. During the first wave of the COVID-19 pandemic, follow-up of patients with BBFA fractures who had undergone surgery before the lockdown was severely affected. To understand the effect of lack of regular follow-up on the outcome of BBFA fracture patients, in this study, we assessed their radiological, functional, and clinical outcomes at least 12 months after surgery. This study examined if a lack of routine follow-ups in surgically treated BBFA fracture patients has any impact on their short-term outcomes. Methods: We included 30 patients with BBFA fractures who were operated prior to the COVID-19 lockdown and assessed their radiological, functional, and clinical outcomes 12 months after surgery. Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) score, Patient-Rated Wrist Evaluation (PRWE) score, Grace and Eversmann's score, and Mayo Elbow Performance Index (MEPI) score were assessed subjectively. Fracture site tenderness, and wrist, forearm, elbow, and grip strength range of motion (ROM) were objectively evaluated. Radiological union was recorded using standard forearm anteroposterior and lateral radiography. Results: At follow-up, 28 patients had union at the fracture site, and two patients had a nonunion. A significant reduction was observed in the mean ROM of the injured forearm compared with the uninjured forearm in supination (17.76% less), pronation (31.4% less), dorsiflexion (32% less), palmar-flexion (24.6% less), elbow flexion-extension arc (2.5% less), and grip strength (18% less). The percentage reduction in pronation and dorsiflexion was higher than that in supination and palmar-flexion, respectively. Grace and Eversmann's score was excellent in 16 patients, good in 4, acceptable in 7, and poor in 3 patients. The mean QuickDASH score was 6 ± 6.6. The mean PRWE and MEPI scores were 7 ± 4.5 and 87.16, respectively. The MEPI score was excellent in 21 patients, good in 6, fair in 2, and poor in 1 patient. Conclusion: The clinical, functional, and radiological outcomes of adult patients with BBFA fractures who were treated with compression plating were satisfactory. Inadequate follow-up during the COVID-19 first wave in India had minimal to no effect on their short-term outcomes.

Keywords: Both-bone forearm, fractures, COVID-19, outcomes

Introduction

The COVID 19 pandemic has affected everyone's life. It has had a huge impact on the healthcare delivery system [1]. To contain the COVID-19 pandemic, the government of India announced, like many countries globally, a complete nationwide lockdown during the first wave [2]. In India, the lockdown was enforced from the second half of March 2020 to October 2020, with intermittent periods of limited relaxation. The movement of people was strictly curbed. Most tertiary healthcare centers were only allowed to treat limited emergency conditions, and outpatient services were completely curtailed to mobilize healthcare personnel and resources for managing the pandemic [3].

Both-bone forearm (BBFA) fractures are commonly encountered injuries in the emergency

department. The fractures affect males more than females and affects mostly age group 30-45 years. Road traffic accident (RTA), fall and assault are the common mode of injury [4]. Management of adult BBFA is surgical as restoration of forearm rotation, elbow and wrist motion and grip strength management has been shown to be facilitated by anatomic reduction and internal fixation of these fractures. Moreover, undisplaced fractures are also known to get displaced when managed with cast [4]. Internal fixation with plating is the primary mode of treatment in adults and adolescents [5]. The plates used for internal fixation are 3.5 dynamic compression plate (DCP) and 3.5 mm Limited Contact Dynamic Compression Plate (LCDCP). Regular postoperative follow-up is necessary to ensure satisfactory progress. Patient-reported outcome measures (PROMs) are essential for evaluation of quality of life following surgical procedure [6, 7]. During the first wave of the pandemic, follow-up of patients who had undergone surgeries prior to the lockdown was severely impacted. While there may be arguments that lack of regular follow-up should not affect the surgical outcome, this might not necessarily be true. During each visit, the surgeon reinforces the importance of following some precautions till union and appropriate rehabilitation for optimal recovery. There is paucity of data on the impact of the COVID-19 pandemic on PROMs in patients who underwent surgery. While Bonsel and coworkers found minimal effect on COVID-19 lockdown in patients undergoing hip and knee arthroplasty, Lin et al. reported an adverse impact in patients undergoing spine surgery [8, 9]. The present study aims to examine the lack of routine follow-up on the clinical, radiological and functional including the short-term PROMs in surgically treated BBFA fracture.

Materials and methods

Study design

This retrospective cross-sectional study was conducted after receiving the approval of our institutional human ethics committee (Ref. No. IHECPGRMD014), and we followed the STROBE guidelines. Patients operated between January and April 2020 were included in the study. The study duration was from January 2021 to June 2021. Informed consent was obtained from all patients before their participation in the study.

Inclusion and exclusion criterion

Patients of either sex who were older than 14 years of age and had diaphyseal BBFA fractures operated with compression plating at our tertiary care teaching hospital in the aforementioned period (enforcement of the first nationwide lockdown in India) were invited to participate in the study. Only patients who had completed a minimum of 12 months after surgery were included. Those who had a single bone forearm fracture, diaphyseal fracture in one bone and metaphyseal fracture in the other bone, pathological fractures, or associated injury to the shoulder, wrist, elbow, and hand of the same or contralateral upper limb or those having head injury were excluded. Similarly, patients who had an intermittent follow-up (before 1 year) after surgery were also omitted from the evaluation.

Data

Demographic details of the patients, such as age, gender, mode of injury, fracture characteristics (AO/OTA), and type of injury (open/closed), were noted. A comprehensive clinical, radiological, and functional evaluation of the patients was also conducted. Clinical examination conducted included examining for healing (scar tenderness/scar hypertrophy) and measuring the range of pronation/supination of the forearm and flexion/extension of the wrist and elbow. Thorough neurological examination of the limb was also performed. Grip strength was measured using a hand grip dynamometer. Standard anteroposterior and lateral radiographs of the forearm were used for radiological evaluation. Radiological union at the fracture site, delayed union, nonunion, radioulnar synostosis (if any), and implant loosening were recorded. Functional outcomes included PROMs determined on the basis of the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) score (0 points indicate a perfectly functioning upper extremity, whereas 100 points indicate complete impairment), Patient-Rated Wrist Evaluation (PRWE) score, and Mayo Elbow Performance Index (MEPI) score [10-12]. At least 10 of the 11 items must be completed for a score to be calculated. The assigned val-

ues for all completed responses are simply summed and averaged, producing a score out of five. This value is then transformed to a score out of 100 subtracting one and multiplying by 25. This transformation is done to make the score easier to compare to other measures scaled on a 0-100 scale. A higher score indicates greater disability (0 points indicates a perfectly functioning upper extremity, whereas 100 points indicates complete impairment) ((sum of n responses/n) - 1) ×25, where n is equal to the number of completed responses [10]. PRWE is a self-administered, patient-specific questionnaire that consists of 15 items. The pain subscale score is the sum of the five items. The function subscale score is calculated by the sum of the ten items divided by two. The total score of the PRWE is the sum of the scores of both subscales. A score of 100 represents the worst functional score, whereas 0 represents no disability [11]. MEPI uses four subscales - pain, range of motion, stability and daily function. The Total score is 100 and clinical information is rated out of it. There are four grades - excellent-90-100, good-75-89, fair-60-74, poor less than 60 [12]. The final outcomes of forearm function were reported as excellent, good, acceptable, and poor based on Grace and Eversmann's score. The results were reported as follows: "excellent" when complete union and >90% of the normal forearm rotation were observed; "good" when no union but 80%-89% of the normal forearm rotation was achieved; "acceptable" when union was observed along with 60%-79% of the normal forearm rotation; and "unacceptable" when a non-union was observed [13].

Any complications that occurred at this time were also noted.

Statistical analysis

The outcome measures for the affected and unaffected arms were compared using the Statistical Package for the Social Sciences (SPSS) version 25, IBM corp, New York. Demographic and descriptive data were represented as number and percentages. Parametric data were expressed as mean ± standard deviation and compared between two groups using an independent t-test, while non-parametric data using Mann Whitney U test. All analyses were two-tailed, and the results were discussed at a 5% significance level, that is, $P \leq 0.05$ was considered statistically significant.

Results

Participants

Of the 30 patients, 24 were male patients and 6 were female patients. The patients' age varied from 14 to 69 years. RTA was the most common cause of injury. The left forearm was affected more than the right. Fourteen patients were the laborers, 6 were students, 3 were homemakers, and 6 were office goers. Majority of the fractures were closed fractures. The details of the participants are given in **Table 1**.

Fracture pattern (based on the AO classification)

Fractures were classified according to the AO/OTA classification system [14]. The oblique fracture was the most common fracture in the radius and ulna (**Table 2**).

Clinical outcomes

Surgical scar tenderness, surgical scar hypertrophy, or fracture site tenderness at the radius or ulna was not observed in any of the patients. However, 1 patient had posterior interosseous nerve (PIN) palsy in the immediate postoperative period; the patient had recovered at the follow-up.

The mean percentage difference between pronation and supination was 31% and 17.6% less in the injured forearm than in the uninjured forearm. Similarly, the wrist dorsiflexion was more affected than the wrist palmar-flexion. At the last follow-up visit, the reduction in the ROM and grip strength of the affected side was significantly higher than that in the unaffected side. The detail clinical outcomes are presented in **Table 3**.

Radiographic outcomes

Union was achieved in 28 patients (93%). One such case is illustrated in **Figure 1**. Non-union and implant loosening were observed in 2 patients. Both patients had open injuries. One such case is illustrated in **Figure 2**.

Table 1. Demographic details of the patients

Variables	Group	Number	Percentage
Age	0-20	4	13.33
	20-40	15	50
	40-60	9	30
	>60	2	6.67
Sex	Male	24	80
	Female	6	20
Side	Right	12	40
	Left	18	26.67
Mechanism of injury	Road traffic accidents	15	50
	Fall/Slip	12	40
	Assault	2	6.67
	Industrial accident	1	3.33

Table 2. Fracture pattern as per AO/OTA classification

Site of fracture in the forearm	Fracture patterns of Radius		Fracture patterns of Ulna	
Proximal 1/3rd N=4	2R2A3	1	2U2A2	2
	2R2B2	1	2U2C2	1
	2R2B3	1	2U2A3	1
	2R2C2	1		
Middle 1/3rd N=18	2R2A2	10	2U2A2	11
	2R2A3	6	2U2A3	1
	2R2B2	2	2U2B3	1
			2U2B2	2
			2U2C2	2
			2U2C3	1
Distal 1/3rd N=8	2R2A2	2	2U2A2	4
	2R2A3	4	2U2A3	3
	2R2B2	1	2U2B3	1
	2R2B3	1		

PROMs (functional scores)

The mean QuickDASH score was 6 ± 6.6 (0-25). The mean PRWE score was 7 ± 4.5 (0-0.5). The mean MEPI score was 87.16 ± 9.23 (50-100). Overall, the Grace and Eversmann's score was excellent in 16 (53.33%) patients, good in 4 (13.33%), acceptable in 7 (23.33%), and poor in 3 (10%) patients.

Complications

Nonunion was observed in 2 patients. One case is illustrated in **Figure 2**. One patient had a superficial surgical site infection, which was resolved with oral antibiotics and surgical wound care. One patient with PIN palsy in the immediate postoperative period recovered 3 months after surgery.

Discussion

Joshua et al. studied the impact of COVID-19 lockdown on PROMs in the Dutch hip and knee arthroplasty patients [5]. They found that post-operative PROMs in patients with either hip and knee replacement differed minimally, which is not clinically relevant. In another study, Attaripour et al. observed that outcomes related to pain levels in the short term were higher following surgery but did not persist in the long term [15]. Lin et al. also reported that PROMs at least in the short term during the pandemic were less and suggested psychological support for patients to improve these PROMs [9].

In our study, radiographic union was achieved in 93% cases, whereas nonunion was observed in 7% cases. Patients exhibiting nonunion had open fractures at the time of injury. The time of union could not be studied because of the lack of follow-up during the pandemic. Lee et al. could achieve a 100% union in their ORIF plating group compared with 97% in the intramedullary nailing (IMN) group [16]. Behnke et al. had 4% nonunion in their plating and hybrid fixation groups [17].

In our current series, we achieved a functional range of forearm rotation (50° supination and 50° pronation) in most patients, whereas the elbow ROM was not affected. This is quite similar to the results of the study by Shah et al. who compared IMN to ORIF plating and found 83% of all patients regained full forearm rotation [18]. The functional Grace and Eversmann's scores revealed that >50% of cases had excellent results with another 47% in the good-to-acceptable category. Cases having nonunion at the fracture site had poor clinical outcomes, consistent with the outcomes reported in study of Behnke et al. study [17].

In this study, the mean QuickDASH score was 6.1 (0-25). Williams et al. reported that people

Table 3. Summary of clinical parameters of injured arm in comparison to uninjured arm

Joints	Parameters in degrees	Injured forearm (mean ± SD)	Uninjured forearm (mean ± SD)	Mean reduction of injured forearm when compared to uninjured forearm (In percentage)	*p*-value
Forearm	Supination	73.79 ± 17.67	88.66 ± 3.3	17.7	<0.0001
	Pronation	57.33 ± 15.79	84.66 ± 4.26	31.4	<0.0001
Wrist	Dorsi flexion	47.6 ± 10.85	68 ± 2.5	32.0	<0.0001
	Palmar flexion	52.5 ± 8.14	68 ± 2.5	24.6	<0.0001
	Radial deviation	17 ± 3.59	21.45 ± 2.3	20.7	<0.0001
	Ulnar deviation	19.5 ± 5.5	30 ± 0	35.0	<0.0001
Elbow	Flexion-extension range	138.6 ± 5.86	147.1 ± 4.29	2.5	<0.0001
Grip strength (kg)		35.3 ± 4	43.4 ± 2.89	18	<0.0001

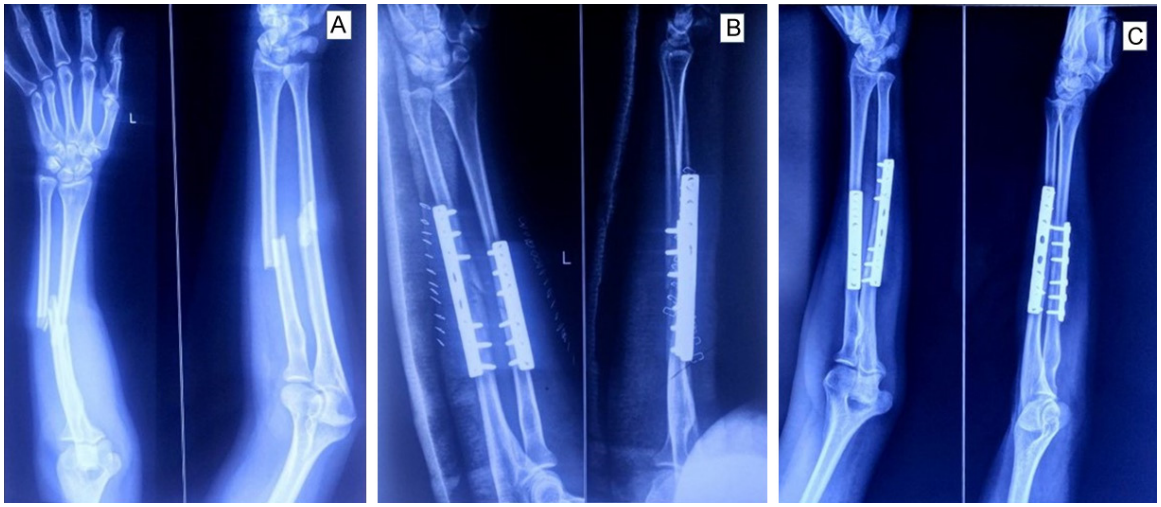

Figure 1. A 32-year-old female with union. A: Grade 1 open fracture in forearm AO 2R2A3, 2U2A2 without any neurovascular deficit; B: Treated with ORIF with DCP for both radius and ulna; C: Follow up at 12 months shown union on the radiographs.

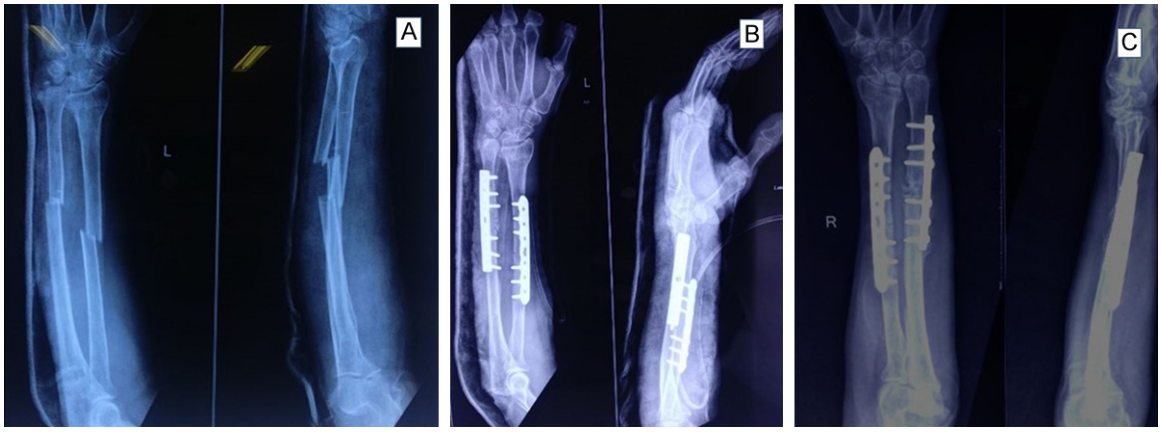

Figure 2. A 45-year-old female with un-union. A: Closed 2R2A2, 2U2A3 without any neurovascular deficit; B: Treated with ORIF with LCDCP for both radius and ulna; C: Follow up at 12 months had shown union on the radiographs.

having QuickDASH scores between 0 and 29 did not consider their upper limb disorder to be a problem [19]. Hence, no one was considered disabled in the study. Most cases in our study had minimal or no limitation of activities in the injured limb. They could perform their activities of daily living and vocational and recreational activities with minimal difficulties. This is higher than that reported by Droll et al. who investigated BBFA fractures in adult patients after plate fixation and reported that the mean QuickDASH score was 18.6 in patients with a mean age of 43.9 years [20]. A better score in our series could be attributable to a greater number of younger patients in our study. Two of our patients having fracture patterns of 2AR2A2, 2U2A2 at the distal 1/3rd shaft and 2R2A2, 2U2A3 at the middle 1/3rd shaft had the lowest QuickDASH score of 0.

Goldfarb et al. found a decrease in the wrist movement following forearm fracture surgery [21]. This prompted us to consider PRWE scores in our study. Droll et al. also reported a significant reduction in the ROM of the wrist, forearm, elbow, and grip strength of the affected arms compared with those of the unaffected arms and a maximum reduction in the range of wrist extension when treated with ORIF plating [20]. Patients had favorable PRWE scores in our series. Similarly, the elbow ROM was also assessed and MEPI scores were also satisfactory.

Compared with the uninjured forearm, the mean percentage difference in the supination and palmar-flexion of the injured forearm was lower than that in pronation and dorsiflexion, respectively. The anterior group of forearm muscles was fibrosed because of the anterior (Henry) approach to the radius and prolonged immobilization in the mid-prone position in a few patients (as they failed to come for follow-up and removed the plaster slab themselves), probably causing reduced dorsiflexion. In the current study, many fractures occurred at the middle 1/3rd and distal 1/3rd of the shaft of the radius and ulna. Therefore, the pronator group of muscles was likely to be affected the most and fibrosed after surgery, which might have led to reduced pronation. These problems can be avoided if the fractures are immobilized in a relatively more dorsiflexed position. Physiotherapy aimed for wrist dorsiflexion and forearm pronation may have altered these in the rehabilitation period, provided the patient had been followed up. As an alternative, Thompson's approach for radius could have been used.

In 2020, Cano-Valderrama [22] conducted a multicenter cohort study investigating the effect of COVID-19 on acute care surgery. The study reported higher morbidity in patients undergoing acute care surgery during the pandemic period. However, no difference was observed in the mortality and re-operation rates. Our results are similar to those of previous studies where other surgeries were conducted during the non-COVID period. The lack of regular follow-up during the COVID-19 first wave probably had a very limited impact on the outcomes of patients having BBFA fractures treated with compression plating.

Our study highlights an unplanned commonly encountered orthopedic trauma, which is operated on a regular basis. This is unlike an acute care surgery that is associated with higher morbidity because of a lack of follow-up visits [22]. A high rate of union complimented good functional outcomes. This result is different from those of previous studies in patients undergoing arthroplasty or spine surgeries, which are more elective in majority of cases [8, 9]. We do agree that the sample size in the study was small as data only from a single institution were included. However, our results are almost similar to those observed during the "normal" time and encouraging.

Conclusion

The clinical, functional, and radiological outcomes of patients with BBFA fractures treated with compression plating were satisfactory. Forearm pronation and wrist dorsiflexion were affected. However, the overall results were comparable to those in the regular non-pandemic times. We found that inadequate follow-up during the first wave of the COVID-19 pandemic in India had minimal to no effect on the clinical outcomes and PROMs in patients undergoing surgery for BBFA fractures.

Disclosure of conflict of interest

None.

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