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Results of 70 consecutive ulnar nightstick fractures☆

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ABSTRACT

Background: Adult isolated ulnar shaft fractures (IUSFs) are uncommon, and treatment remains controversial. The purpose of this study was to compare results of operative (reduction internal fixation (RIF)) and nonoperative treatment (NOT) in patients with IUSF.
Material and methods: A retrospective case–control analysis was undertaken on patients diagnosed with IUSF between 2002 and 2008 at a Level I teaching trauma center. Clinical outcomes consisted of complications and functional ability.
Results: Seventy patients had a mean age of 44.6 years (18–86) and a body mass index (BMI) of 27.9 (17–47). The mechanism of injury included high-energy injuries (60/70, 85.7%), low-energy falls (8/70, 11.4%), and sports (2/70, 2.9%). Treatment consisted of 33/70 (47.1%) NOT and 37/70 (52.9%) RIF. The AO/OTA fracture classification was 48 A1, 20 B2, and two C1. The level of activity (LOA) was 60 without restrictions, six with restrictions, and three who did not return to work. The function determined by range of motion was 55/70 (78.6%) full, 11 slightly limited, and one severely limited. A total of 14 nonunions (NUs) and 17 malunions (MUs) occurred. NOT was associated with NU ($\chi^2 = 0.001$) and MU ($\chi^2 = 0.000$), respectively. Fracture angulation $\geq 8^\circ$ was related to the inability to return to previous LOA ($\rho = 0.406$, $p = 0.001$). Secondary displacement >2 mm contributed to MU ($R^2 = 0.238$, $p = 0.000$) and NU ($R^2 = 0.076$, $p = 0.021$). NU was related to a minor functional result ($\rho = 0.315$, $p = 0.009$).
Conclusions: IUSF treatment remains challenging in the adult population. Nonoperative treatment of displaced fractures produces a high risk of complications, and the fracture characteristics determine patient outcome.
Level of evidence: Level III.

Introduction

Isolated ulnar shaft fractures (IUSFs) are uncommon [1,2], and they can result from low-energy [3,4] and high-energy mechanisms of injury [5–10]. The ulna and radius form a functional unit [11]; therefore, malangulation in isolated ulnar fractures can lead to functional limitation of the forearm [12,13]. However, the controversy concerning the optimal treatment regimen remains. Non-displaced or stable IUSF can be treated nonoperatively by immobilization in a cast [7,9], functional bracing [14,15], or functional treatment without immobilization [1,8,16]. In the case of displacement, operative treatment is recommended. However, indications are still accompanied by dissent [4,5,9,17]. External fixation, intramedullary stabilization, and plating are optional. Nonoperative and operative treatments have shown good results [1,10,18,19]. Plate fixation evidenced anatomic healing in >90% [5,20]. Complications resulting from the IUSF treatment are common including nonunions (NUs), malunions (MUs), limitations in range of motion (ROM), and pain [1,3,5–7,21–24].

The purpose of this study was to compare results, function, and complications of nonoperatively and operatively treated IUSFs

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based on age, gender, body mass index (BMI), fracture characteristics, and associated injuries (AIs).

Materials and methods

This investigation was a retrospective case–control study of non-operatively and operatively treated IUSF at a single private practice associated with a Level I teaching trauma center. Treatment was on the discretion of 10 fellowship-trained orthopaedic surgeons. Consecutive patients were identified by CPT (Current Procedural Terminology) codes 25530, 25535, 25545, 25560, 25565, 25574, and 25575 for ulnar fractures who underwent initial treatment from March 2002 through December 2008. The inclusion criteria were radiographically diagnosed IUSF, skeletal maturity, and initial treatment at study institution. The exclusion criteria were unavailable radiographic images at injury and at final follow-up and follow-up of <90 days. Associated ipsilateral radial injuries, ulnar olecranon injuries, ulnar styloid fractures, and injuries to the proximal or distal radioulnar joint complex were excluded.

Age, BMI, gender, injury mechanism, and AIs were recorded. The surgical site infection (*SSI*) was assessed [25].

Treatment

IUSFs were grouped according to initial treatment into nonoperative treatment (NOT) or closed/open reduction internal fixation (RIF).

A long- or short-arm cast, splint, or brace (AirCast, Vista, CA, USA) was utilised for 4–6 weeks keeping the patients' forearm immobilised and non-weight bearing. If an isolated injury was present, progressive lifting and weight bearing was initiated based on radiographic and clinical assessment indicating healing and maintenance of reduction. If associated with other upper-extremity injuries requiring non-weight bearing for longer periods of time, therapy was focused on passive ROM exercise. Strengthening and weight bearing were delayed until other injuries warranted therapy. Patients were instructed to begin ROM exercises at home and organised physical therapy for ROM, conditioning, and weight bearing. Radiographic and clinical evaluation was performed on a standardised schedule with follow-up at 2, 4, 8, and 12 weeks. Furthermore, follow-up was performed at 6, 9, and 12 months if indicated.

If operative fixation was indicated, a dorsal incision was carried out centred over the ulnar shaft at the dorsal forearm. Under protection of the neurovascular bundle, the interval between the extensor carpi ulnaris and the flexor carpi ulnaris was entered to advance to the ulnar bone. Keeping as many soft tissue attachments to the fracture fragments as possible, the fracture edges were cleaned and refined, and the fracture was reduced. Techniques of fixation varied depending on the fracture pattern and surgeon preference, respectively. Postoperatively, a short-arm cast or splint was worn for 2–4 weeks until wound healing was completed with restrictions of non-weight bearing. Early active ROM was started for the upper-extremity joints. Radiographic and clinical examinations were performed as outlined above.

Radiographic analysis

Standard radiographic images (AP and Lat) of the injured forearm, obtained at the time of injury, at 1 month and final follow-up, were retrospectively reviewed in a blinded fashion by one author (MOC). Radiographs were used to assess the degree and direction of displacement, degree of comminution, alignment, presence of AIs, adequacy of reduction, presence of hardware loosening, time to healing, and presence of healing disturbances (malangulation and NUs [5]).

In each plane angulation, the displacement and fracture angle were measured. The lengths of the proximal and distal fragment were measured and the fragment ratio was calculated. An angulation of $\geq 10^{\circ}$ at final follow-up was defined as MU [13]. The axis of the distal radius and the ulnar length variance (UL±) were determined [26,27]. Variance measuring <-2 mm (normal 1 ± 1.5 mm [26]) indicated ulnar shortening.

Classification was based on fracture pattern [22] and according to the AO/OTA classification of 2007 [28]. Fracture location was discriminated into equal proportions of the ulnar diaphysis in the proximal, middle, and distal thirds [29].

The adequacy of reduction was assessed on the immediate post-interventional radiographs modified from Leung et al. [20]. Anatomical (excellent) reduction was defined as restoration of anatomy (no gaps or steps) and reestablishment of axial alignment. A near-anatomical (good) reduction was present if axial angulation was $<10^{\circ}$, shortening was <2 mm, and displacement was below 25%. Nonanatomic (bad) reduction was defined as axial angulation in any plane $\geq 10^{\circ}$, shortening of >2 mm, or displacement >25%.

Clinical and functional outcome

Local pain was recorded as present or absent. ROM was rated as full, slightly affected, severely affected, or totally stiff, as modified from Anderson et al. [17]. Furthermore, the results were classified according to Zych et al. [9] and Leung et al. [20]. The grip strength was rated as full, slightly reduced, moderately reduced (half of opposite), or severely reduced. The type of work and level of activity (LOA) were recorded. LOA was rated as: (1) pre-trauma, (2) some change or work restrictions, and (3) did not resume activity or employment.

Statistical methods

Data analysis was performed using the IBM Statistical Package for the Social Sciences (SPSS®) Statistics version 19.0 (Chicago, IL, USA). Descriptive statistics (mean, standard deviation, range, and percentages) were completed to describe the sample and clinical and functional results. Pearson's r or Spearman's rho (ρ) correlations and cross tabulations with chi-squared analysis were calculated to determine associations among variables and to explain factors that were related to treatment efficacy. *T*-tests or chi-squared analyses were calculated to determine differences in outcome between groups. Univariate logistical regression analysis was used to determine the contributing factors. The significance level was determined at $p < 0.05$. All end points were analyzed using two-tailed tests unless indicated otherwise.

Results

Demographics

A total of 180 patients met the inclusion criteria. One hundred and eight were excluded because of inadequate follow-up (59/108) or age below 16 years (49/108). Two patients were excluded for incomplete radiographs. The group of excluded adults was not significantly different from the study group regarding injury-related data ($p > 0.51$). Seventy patients with a total of 70 IUSFs formed the basis of this study. Table 1 summarises the demographic variables. Twenty (20/70, 28.6%) were obese (BMI ≥ 30). The follow-up time averaged 12 months (range, 3–62 months).

Most of the patients (40/70, 57.1%) were injured in a motor-vehicle accident. Furthermore, injury mechanisms included direct impact (11), low-energy falls (eight), high-energy falls (five), motor cycle accidents (two), sport injuries (two), and crush injuries (two).