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ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 10, Issue, 09, pp.10079-10085, September, 2019

RESEARCH ARTICLE

THE IATROGENIC RISK FACTORS, AND DEFECTED HEALING PROCESS IN HAND LONG BONE FRACTURES

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ARTICLE INFO

Article History:
Received 20th June, 2019
Received in revised form
12th July, 2019
Accepted 17th August, 2019
Published online 30st September, 2019

Key words:
Malunion,
Risk factors,
Defected healing

ABSTRACT

The plantations of *Acacia* Malunion, refers to fracture healing in less optimal alignment. Clinically presented as twisting, bending, or shortening deformity, solitarily or in combination. That may happens in almost any fractured bone, when fractures untreated, improperly reduced, or inadequately immobilized. Exceptionally, the less protected hand long bones are more susceptible, because of the excessive deforming force tensions exerted on the smaller bony fragments, of the already small skeletal hand chain. Though its causes are known, the risk factors are a multi factorial dilemma including injury and patient factors, as well as our main concern, the iatrogenic risk factors. Here we are investigating retrospectively, the possible iatrogenic risk factors resulting in such defected healing process, In 68 malunited hand fractures, in 59 hands of 58 patients with significant skeletal deformities. following primary management of their original fractures by the emergency orthopaedic teams, at Aljala Teaching Trauma Hospital, Benghazi, between 2013 and 2017.

***Citation: Abdulrahim Aljayar and MD. Consultant Hand Surgeon.* 2019.** "The Iatrogenic Risk Factors, and Defected Healing Process in Hand Long Bone Fractures", *Asian Journal of Science and Technology*, 10, (09), 10079-10085.

INTRODUCTION

Malunion is refers to the defected fractures healing process, resulting in less optimal alignment, presented as angular, rotational, or shortening deformity, solitarily or in a combined axial, and rotational deformities (Wu, 2006; Wu, 2001) (Figure 1). Develops when the fractures either untreated, improperly reduced, or inadequately immobilized. The fractured hand long bones are more at risk, (Haughton *et al*., 2012) because of the excessive deforming force tensions and stress applied on the smaller bony fragments, through the powerful musculature controlling the already small hand skeleton. Malunion can be functional, that can be tolerated and accepted, or nonfunctional with considerable functional disturbances and esthetic disfigurement, for which correction is indicated to restore as much as possible, the pre-fracture hand functions and appearance. Though diagnosis of malunion is obviously clinical, The routine and may be additional special X-ray views are essential for confirmation and more details of the deformity. Also the CT scanning, and MRI, often required to check the cartilaginous and ligamentous issues secondary to misalignment, and abnormal stress distribution. Although causes of malunion are known, the risk factors predisposing to this avoidable complication, is a multi factorial dilemma including, injury and patient factors, as well as our main concern and duties as hand surgeons, The iatrogenic risk factors (Phieffer *et al*., 2006; Perumal 2007; Murray, 2003).Aiming for the assessment of hand fracture management in our emergency department, exposing the magnitude of this avoidable fractures complication, and pointing possible iatrogenic risks predisposing to malunion.

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PATIENTS AND METODS

Out of total (317) revised bony and soft tissue cases, during the years 2013 to 2017. The date, and time of injury and presentation, mechanism of injury, the stated provisional diagnoses, pre and postoperative X-rays, intraoperative findings, offered conservative or surgical treatment, as well as the used type of anesthesia, the help of tourniquet and TV monitoring, In addition to the patient's personal data, Recorded from the available observation cards, admission files, the OT registrations, and discharge papers of 58 patients. Who were exposed to second or more surgical interventions by the hand surgery team, at Aljala Teaching Trauma Hospital of Benghazi. For the correction of 68 significantly nonfunctional malunited hand long bone deformities, in 59 hands. Considering; Angulation of more than 30°, and/or rotation exceeding 10°. A nonfunctional malunion; and Errors, can be avoided by another colleague, at the same level, and under the same circumstances, An iatrogenic error. In this sample: Each fractured bone considered individually, even where multiple at the same hand.

Excluded are; the cases initially treated in other hospitals than Aljala 17 cases, open fractures 6, epiphyseal injuries during initial trauma 8, and the carpal bone malunited fractures 4. In addition to 21 cases of malunion, excluded because of lack of documentation and/or communication.

RESULTS

Out of total (317), revised bony and soft tissue procedures performed, during five years, between (2013 and 2017). Sixty-eight, corrected malunited hand fractures, in 59 hands of 58 patients. (51 Males and 7 Females) (Figure 1). All patients were young, active and mentally stable, between 13 & 56 years of age. The involvement was bilateral in one patient, and fractures were multiple in 8 hands. All patients attended or brought to, the casualty department within average 30 min post trauma. The problem of malunion, observed more frequently in relation to the 39 metacarpal fractures, commonly complicates neck fractures 16, Whereas counted 29, in relation to phalangeal fractures (PP 15, MP 6, DP 8) (Figure 3). In both (metacarpal and phalanges), the problem is repeatedly associated to the geometrically transverse fracture patterns 28. six, of 68 fractures were misdiagnosed initially, 19 of the diagnosed 62 fractures, treated conservatively, and the rest 43 fractures managed surgically. The close reduction and percutaneous Kirschner wire fixation, attempted in treatment of 17 fractures, all were inserted centrally longitudinal. While 26 fractures, exposed to open reduction and internal fixation techniques, the K. wires fixation employed in 19 fractures (9 Central (47.3%), 8 crossed (42.1%), and 2 transfixation (10.5 %)), 3 Plate fixation, 2 pullout sutures, and 2 Inter-fragmental screw fixation.

X-ray monitoring, reported only in 16 cases. Suspicion that malunion could be iatrogenic, considered in management of the 6 misdiagnosed fractures as diagnostic errors, and in relation to 18 of the diagnosed and conservatively, or surgically treated 62 fractures. These medical errors confirmed in; 4 of the conservatively treated 19 fractures; 5 of the 17 closely reduced and percutaneous fixed fractures; and in 9 of the 26 openly reduced and internally fixed fractured (K. wire 6, plate 1, pull out suture 2). The indications of our interventions, were the correction of 31 angulation deformities, 22 Combined deformities, 10 Rotational deformities, and shortening 5 cases.

DISCUSSION

Malunion is a common avoidable fractures complication in orthopaedics, and hand surgery (Fusetti, 2002). Often necessitates a second or may be more surgical interventions, longer hospitalization, prolonged disability, significant socioeconomic burdens, and may be psychological stress. Makes correction of nonfunctioning malunion deformities, a worthy challenge. However, malunion is better be avoided and prevented, rather than treated. Unfortunately despite the achieved technical progress, mistakes can still happening, and malunion still can be iatrogenic. In line with other reported data, we also found a higher prevalence of malunion among males, with Male to Female ratio of (7.2:1), which can be attributed to the higher exposure of males to cruel manual works, and violent acts, hence more susceptible to work trauma and injuries. The delayed treatment as a possible factor in this group was eliminated, since all patients have reached the emergency department within average of 30 minutes (range 10 – 3 hours). The problem is frequently related to metacarpal fractures (57.3%), that could be related to the high frequency of the metacarpal fractures, representing between (18–44 %) of all hand fractures, (Kollitz *et al*., 2014; Chung, 2001; Gudmundsen, 2009; Ashkenaze, 1992) next are the fractured proximal phalanges (19.1%), followed by distal phalangeal fractures (14.7%), and least in relation to the middle phalanges fractures (8.8%). (Table 1, Figure 3). Within the metacarpals, frequently complicating the fractured neck region (41.0%), and the potentially unstable transverse fractures, were the most commonly observed site of malunion (41.1%), followed by the oblique (32.3%), and least related to spiral fractures (11.7%). Reaching a proper diagnosis is a prerequisite for all next steps for successful management. The lack of experience, underestimation of injuries, (Guly, 2001; Juhl, 1990) reliance on a single, or poorly exposed X-ray views, and misreading radiographs, (Guly, 2001; Wei, 2006; Halsted, 2004 are common mistakes leading to misdiagnosis, and therefore mismanagement of the fractures (Figure 4). Our appraised rate of misdiagnosis is (8.8%), which is higher than some other reported incidence (3.6%), (Fracture clinic referrals, 1988) and (5.4%) (Wei, 2006). In this series, in addition to the diagnostic errors, the detected unfortunate surgical lapse, made incidence of malunion following primary hand fractures treatment (29%). Which is higher than any other available reports (15%), (Fusetti, 2002) and (10.49%) by Yan and colleagues,(Yan, 2011) . These errors were detected in (34.6%) of the openly reduced and internally fixed fractures, and (29.4%) of the closely reduced and percutaneously fixed fractures, They were least observed among the conservatively treated fractures (21.0%) (Figure 5).

When suitable sized selected, and perfectly inserted, the K. wire fixation looks a practical and effective way of fixation especially in emergency, less invasive, less technically demanding, and mostly does not require further surgical exposure for removal (Kelsch, 2004). However sometimes their use is unsafe because of their limited rigidity in keeping position. The possibility of iatrogenic risk of malunion in this sample, observed frequent in relation to the fractures fixed this way (30.5%), both percutaneously 17, and openly 19. Some see a correlation between timing variable and the rates of fracture's misdiagnosis, reporting higher frequency of these lapses between 8 pm and 2 am, attributing fatigability, and lose of focusing in this period, experienced by emergency duty doctors (Hallas, 2006; Kozer, 2002; Robbins, 1990). It was obvious that, the fragments displacement and/or redisplacement, were common factors disturbing the normal healing process predisposed to the deformities, in the 68 malunited fractures, required our intervention for correction (Figure 6). Other observed iatrogenic causes, may include; the wrong choice of fixation tools, in three fractures; the wrong performance, and unsecured misplacement of these tools, in other 3 cases; the neglected useful help of intraoperative X-ray monitoring in (62.8%) of the surgically managed fractures; the poor follow up; and combinations of some or all of these factors in 12 cases (Figure 7) (Table 1). The average time between the initial trauma and our interferences was 9 months, ranging between 4 to13 months, However, some surgeons reported good results of corrective osteoclasia, may be for as early as the 6th week post primary management, (Buchler, 1996; Light, 1987) others prefer to wait for union to be established, to correct by osteotomy.

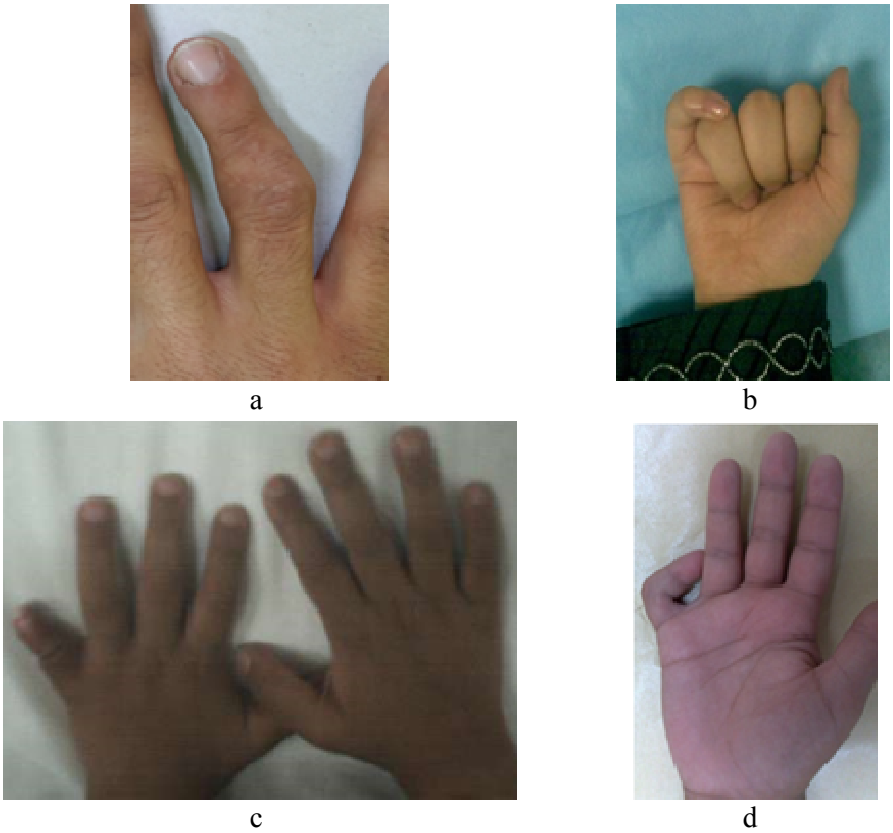


Figure 1. The clinical presentation of malunion, a- angulation, b- rotation, c- shortening, d- combined malalignment

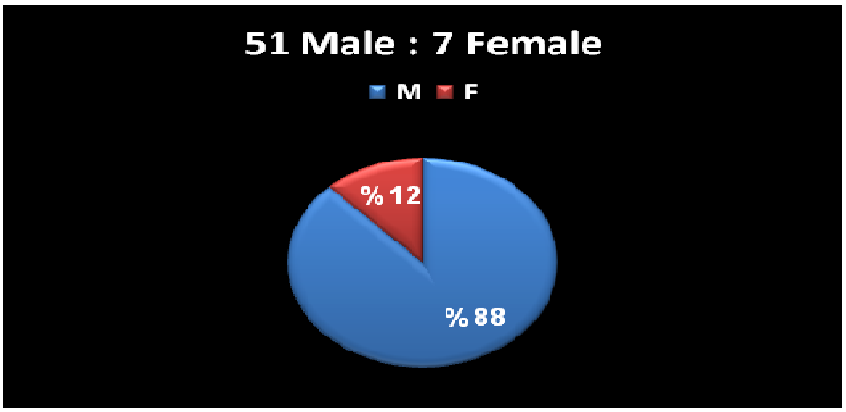


Figure 2. Sex variance of malunnion, with Male to Female ratio of 7.2:1

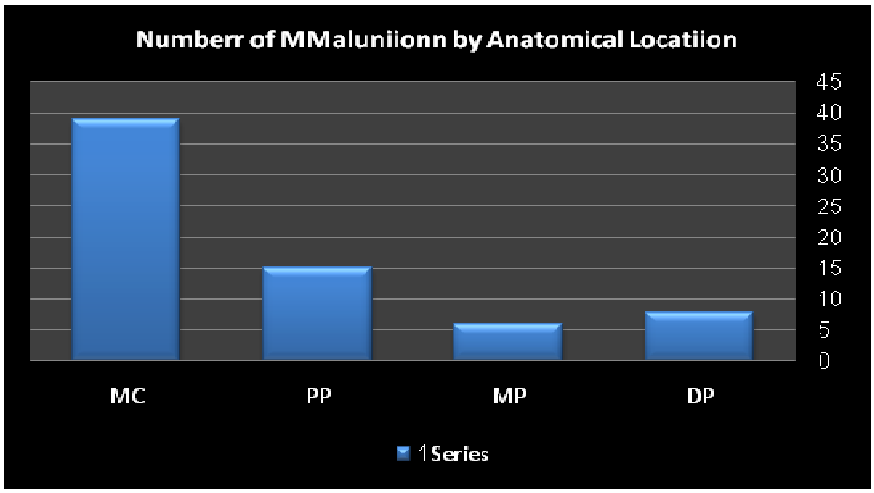
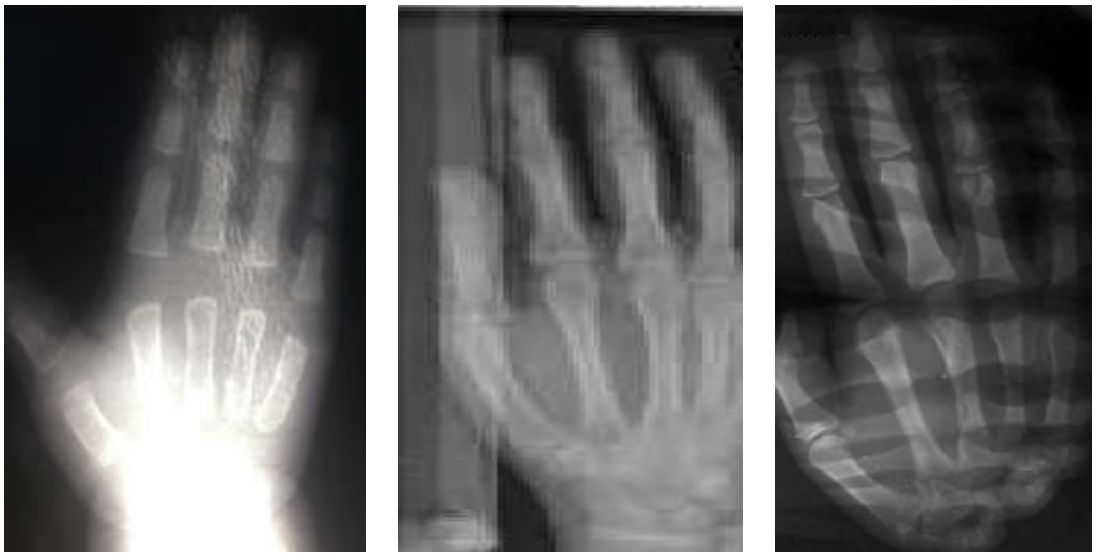
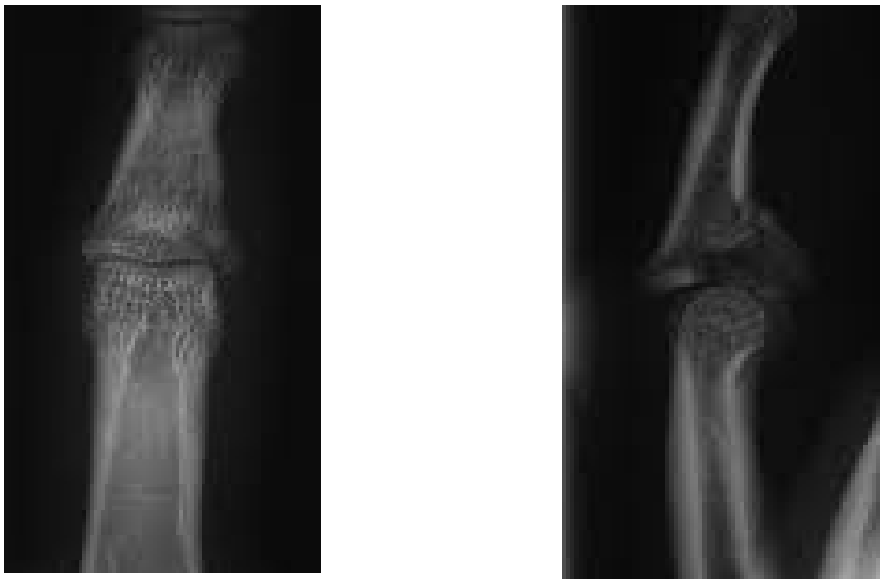


Figure 3. The frequency of malunion in relation to anatomical location, Metacarpals (MC)39, Proximal phalanges (PP)15, Meddle phalanges (MP)6, Distal phalanges (DP)8.



(a)



(b)

(c)

Figure 4. Acceptance of poorly exposed (a), and single X-ray views (b & c) are among the common causes of diagnostic errors

Figure 5. Examples of inadequate conservative immobilization

Figure 6. Failure of proper reduction, of displaced fragments, or their redisplacement following inadequate immobilisation or fixation of the initially achieved reduction

Table 1 .Types and rates of malunion by anatomical site. Where the metacarpals

Site	No.	Malunion			
		Angulation	Rotation	Shortening	Compined
MC	39	12	6	5	13
PP	13	7	3	0	7
MP	6	4	0	0	1
DP	10	8	1	0	1
Total	68	31	10	5	22

(a) (b) (c)

Continu……


(d)


(e)


(f)


(g)

Though some authors mentioned that, most malunions involve a combined rotational, angular, or shortening deformities, there is usually one major component to the deformity that is causing the functional problem (Buchler, 1996; Gollamudi, 2000). In this sample, the correction of angulation deformity was the most frequent indication of our interventions (45.5%), the combined deformities came next (32.3%), followed by the rotational deformities (14.7%), and least were the shortening deformities (7.3%) (Tables 1)

While the most frequent deformity is the angulation malunion (45.5%), the combined deformities come next (32.3%), followed by the rotation (14.7%), and least are the shortening malunion (7.3%).

Conclusion

Although studies on the iatrogenic causes of complications are few for various medical and non-medical reasons, including our human tendency not to reveal our own mistakes, Such studies are very important to track weaknesses, and know where we are. Our unfortunate findings that are doubled or tripled the reachable incidences, are no doubtfully pointing a lack of effective juniors guidance and tracing, Without underrating the administrative part for completion of work, That in-all hinting a system issue.

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