

# Severely comminuted radius fracture presenting as a signature patterned injury

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## ABSTRACT

Dilemma still prevails, regarding the exact management of mangled extremity injuries between limb salvage versus amputation, each having their own set of complications. We here present a case of severely comminuted fractures of radius (bag of bones) along with the multiple criss-cross shaped lacerated wounds on the forearm and wrist presenting as a “signature pattern injury” caused by entrapment of the limb in the concrete mixer. MESS score of patient was 8, a score valid for amputation, but contrary, we successfully salvaged the patient’s limb with use of radio-carpal distracter. Management of mangled injuries should be individualized, with due consideration to the mechanism and force of injury, associated injuries, and the patient profile.

**Key words:** Bag of bones, severely comminuted fracture, signature patterned fracture, radius

**MeSH terms:** Radius fractures, radius, fractures, bone, fracture fixation

## INTRODUCTION

Dilemma still prevails, regarding the exact management of mangled extremity injuries between limb salvage versus amputation, each having their own set of complications.<sup>1</sup> Injury severity scores, may help in deciding between amputation and salvage, but they lack reliability. Hence surgeon should be flexible in deciding the treatment option as per the individual patient.<sup>2-4</sup> We here present a case of mangled upper limb injury, presenting as a signature patterned injury caused by the entrapment of the limb in the concrete mixer and presenting as severely comminuted criss-cross fracture of the distal and middle radius, metacarpals and phalanx (bag of bones) along with the multiple criss-cross shaped, lacerated wounds on the forearm and wrist, which was successfully treated by limb salvage procedure.

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## CASE REPORT

A 35-year-old male, manual laborer by occupation, with left hand dominance, presented to the casualty department, sustaining an accidental injury due to entrapment of his left upper limb in concrete mixer while working. He presented after a delay of 24 h as the patient was referred from primary health center. The patient was transiently hypotensive with blood pressure below 90 but responded well to intravenous fluid.

He sustained severe crush injury of the left forearm, wrist and hand. There were multiple lacerated wounds, around 15-20 in number, criss-cross in shape, each approximately 3 cm × 2 cm in size serially longitudinally arranged on both volar and dorsal aspect of forearm, wrist and hand, on the radial side of limb, sustained due to entrapment of limb in rotating concrete mixer, caused by the rotating motor blades. The skin and muscles were severely crushed over the radial side of forearm, wrist and palmer aspect of the thenar eminence. The thumb was attached with skin tags only. The tendons and muscles were normal over hypothenar area. Multiple small bone pieces of the radius were seen and can be palpated from the wound, whereas surprisingly the ulna was felt intact. The wound was grossly contaminated. Surprisingly all active finger movements were present though reduced, in all four fingers except the thumb. Ulnar pulse was palpable whereas radial pulsations were absent clinically as well as on color doppler. Capillary reflow was sluggish on the radial side. Hypoesthesia was present only on dorsum in first web space, whereas ulnar and median nerves were intact. The elbow, arm and the shoulder were

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normal. The mangled extremity severity score (MESS) of the limb was 8 (age group – 30-50 [1 point], shock group - transiently hypotensive [1 point], skeletal/soft tissue group - medium energy injury [2 point], ischemia group – moderate [2 point], ischaemia time >6 h [2 point]).

Primarily, gross contamination was removed by thorough irrigation of the wound and primary splintage done, which was followed by administration of third-generation cephalosporin antibiotics and tenatus toxoid. Thus after stabilizing the patient haemo-dynamically, anteroposterior (AP) and lateral radiographs of the entire affected forearm, wrist and hand were taken, which showed severely comminuted fracture with multiple bony pieces arranged in criss-cross pattern in middle and distal third radius (bag of bones), along with intraarticular extension. Ulna and all the carpals were intact with maintenance of the inter-carpal relation. The radiological examination of the hand showed comminuted fracture of 1<sup>st</sup> and 2<sup>nd</sup> metacarpal, with crushed thumb and severely comminuted fracture of the proximal and distal phalanx of the thumb [Figure 1].

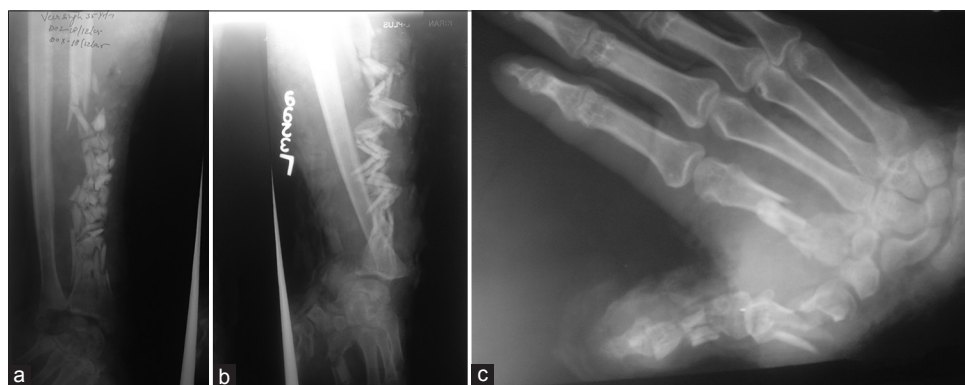
Although MESS score of the patient was >7 a score validate for amputation, we, on the contrary, planned the patient for limb salvage reconstructive surgery. Under brachial block, in the supine position, initial debridement along with thorough irrigation of the wound was done, with removal of all dead necrotic tissues and refreshing the muscles and skin, till fresh bleeding points. The free loose bone pieces seen, were removed. As the thumb was severely crushed and was attached with only skin tag, which was impossible to reconstruction and hence the thumb was amputated from the metacarpophalangeal joint. After the debridement and thumb amputation, multiple lacerated wounds on the volar and dorsal aspect were closed in layers, whereas the wound on the dorso-radial surface of the wrist and hand was left open for regular dressing as it was not possible to

close it primarily. This was followed by stabilization of the fractures, by application of a radio-metacarpal distracter maintaining the length of radius by passing two 3 mm schanz pins proximal to the fracture, in middle third radius at mid forearm between the brachioradialis and extensor carpi radialis brevis muscles and the two schanz pin distally, in the neck of the 2<sup>nd</sup> metacarpal, as the base of the 2<sup>nd</sup> metacarpal was also fractured [Figure 2].

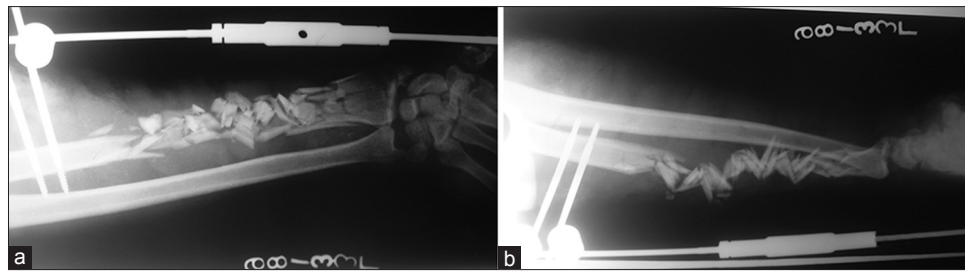
Regular dressing and antibiotics continued till 5 days and as the dorso-radial wound improved, split skin grafting was done. Sutures were removed after 2 weeks. Patient continued on radio-metacarpal distracter till 6 weeks followed by below elbow cast for further 4 weeks. Range of motion (ROM) exercises for elbow and fingers started with below elbow cast in place. ROM exercises for wrist also started after cast removal. Sound bony union was seen at 7 months with wound healing with no signs of infection, although with some amount of malunion and ulnar variance [Figure 3]. Elbow had full ROM whereas wrist had 30° of each palmar-flexion and dorsi-flexion. Fingers had near normal ROM. Pronation of the limb was about 70° and supination was restricted to 50°. Grip strength was about 75% compared to contra lateral side even without the thumb as tested objectively with dynamometer. Patient is being considered for pollicisation of the index finger for better functioning of the hand. At final followup of 7 months, both the dorsal and palmar sensation was intact except at dorsal first web space. Further, as thumb was amputated the strength, prehension ability and performance was reduced.

## DISCUSSION

Although the mangled extremities are very common injuries, but this case drew our attention because of few reasons, - firstly because of the unusual mechanism and pattern of injury, leading to such extremely comminuted



**Figure 1:** Preoperative anteroposterior (AP) (a) and lateral (b) X-ray of forearm with wrist and AP (c) X-rays of hand with wrist of the patient showing severely comminuted middle and distal radius fracture (bag of bones), with intraarticular extension with fracture 1<sup>st</sup> and 2<sup>nd</sup> metacarpal, with crushed thumb and severely comminuted fracture of the proximal and distal phalanx of the thumb and intact ulna and carpals and maintenance of the inter-carpal relation



**Figure 2:** Immediate postoperative anteroposterior (a) and lateral (b) X-ray of the forearm with wrist showing application of the radio-carpal distracter



**Figure 3:** Anteroposterior (a) and lateral (b) X-ray at final followup (7 months) showing sound union. (c and d) Clinical photographs of the patient showing functional outcome (e and f) Clinical photograph showing palmar-flexion and dorsi-flexion

fractures in forearm and wrist bones (bag of bones), secondly the specific “signature patterned injury” caused by the entrapment of the limb in the rotating concrete mixer and lastly due to dilemma arising in treating such extremely comminuted fractures presenting as mangled extremity between limb salvage versus amputation. Further in the literature review, no such extremely comminuted fracture of the radius, involving almost more than half of the length of the radius and involving the wrist and hand, presenting as signature patterned injury is described to our knowledge. Our case, a typical signature pattern fracture caused by a medium velocity injury and without bone loss, was different from the extremely comminuted, multifragmentary fractures described in literature, which are mainly for lower limb bones, because the latter are very high velocity injuries associated with bone loss and further they differ in management and outcome needs for patient.<sup>6-8</sup>

The force and the amount of impact and the position of the hand and wrist (carpal bones), determines the pattern and displacement of bony fragmentations and the extent of frequently, associated concomitant ligament and carpal bone injury.<sup>9</sup> Comminuted fractures as such, are caused by high-energy trauma in young patients and even by low-energy trauma, but in the elderly patients.<sup>9-12</sup> In our case, extremely comminuted fractures of the distal and middle radius, metacarpals and phalanx were caused, in a young male patient even by a moderate velocity injury, by the entrapment of upper limb in a rotating concrete mixer. Inside the rotating concrete mixer ring are 2-4 obliquely placed, the shaft or the motor blades, which also revolves continuously at same speed of around 20 rpm along with the ring unidirectionally, thus helping in mixing the cement all round. As the limb got entrapped in the rotating mixer, the metal shafts or motor blades contacted multiple times with the forearm, wrist and hand, with each turn but only



hitting the lateral aspect of limb thus effecting only radius, lateral wrist and thumb, and causing typical patterned injury of severely comminuted multiple criss-cross fractures of radius (bag of bones) along with the multiple criss-cross shaped lacerated wounds on the forearm and wrist but only laterally. Such severely comminuted multifragmentary criss-cross fractures of bones (bag of bones) along with the multiple criss-cross shaped lacerated wounds only on one side of limb, can be a “signature pattern injury” caused by entrapment of limb in a revolving object making multiple contacts with the limb, on one side only, like concrete mixer grinder, mixer and revolving wheel etc.

Decision whether to perform limb salvage or amputation, for such injuries may be difficult.<sup>1,13</sup> An upper limb amputation leaves dramatic impact on patient’s livelihood and ability to carry out activities of daily living affecting social, economic and family life of the patient.<sup>14-16</sup> Salvage of the severely mangled extremity, despite advances and techniques in reconstructive surgery, is challenging and prone to complications like nonunion, infection, multiple surgeries, longer hospital stays and high rates of secondary amputation along with increased economic burden. Even many times the salvaged limb is nonfunctional and useless, leading to the physical, psychological, financial and social effects making the patient more disabled than did patients with early amputation and in these patients amputation is the most appropriate reconstruction.<sup>1-4,13,17</sup> Injury severity scores, which helps to decide between amputation or limb salvage, lacks reliability and hence are of limited usefulness and should not be the sole criterion to determine whether amputation is indicated.<sup>2,4,13</sup>

Since the salvage was considered, the further options regarding the choice of implant and surgery were very limited, due to the amount of comminution and compounding involved in radial length. Due to rarity and typical fracture pattern, the fracture could not be classified as per the known classifications systems,<sup>18</sup> thus could not help us to guide for the treatment plan.

Finally for maintenance of the radius length, keeping the fracture ends distracted and assessing the wound simultaneously along with moderate unloading of the carpus and stabilization of the fracture, we planned the patient for radiocarpal distracter. We believe that the external fixator is suitable for the reduction of the fragments in severely comminuted distal radius fractures and have the versatility to align the carpus correctly with the wrist and also allowing for additional fixation of the intraarticular fragments simultaneously by K-wires, and simultaneously wound assessment regularly in case of compound or mangled extremity, although we didn’t used any additional K-wires for the intraarticular fracture fragment. With the use of the radio-metacarpal distractor alone, we were able to attain

adequate alignment and articular congruity in AP view, but even with the distraction, due to severe comminution and many free bony pieces without any soft tissue attachment could not be aligned in lateral view. However, we accepted the reduction as such, because priority was to salvage the limb, with minimal effort.

As the pins were inserted after predrilling, taking care to avoid injury to the nerve, vessels and musculo-tendons tethering with use of drill guides, none of our pins got infected or loosened. Union was also delayed in our case as severe comminution resulted in extensive periosteal or endosteal damage. Further, for better functioning of the hand, polycisation of the index finger is being considered for the patient.

To conclude, injury severity scores should not be the sole criteria for deciding for amputation the limb. Treatment of such injuries should be individualized, with consideration to the mechanism and force of the injury, associated injuries and the condition and needs of the patient.

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