

3D Modeling using Rapid Prototyping: Case Study of Distal Humerus Fracture

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Abstract - The Locking Compression Plate gives a number of advantages in fracture fixation, combining angular stability through the use of locking screws with traditional fixation techniques. In the epimetaphyseal area, compression plate implant particularly suitable for use in poor bone stock and complex joint fractures. However, patient specific implant designing is complex and requiring careful attention to biomechanical principles as well as a number of potential pitfalls needs to be considered. The purpose of this study was to review the customized preparation of compression plate as per the requirement of patient.

Keywords: Locking compression plate (LCP), CT scan, X-ray, 3D modeling, Prototype.

I. INTRODUCTION

The actual elbow consists of portions of all three bones of the arm:

1. The distal humerus is the center of the elbow hinge.
2. The radial head moves around the distal humerus also rotate when the wrist is turned up and down.
3. The olecranon is the part of the ulna that cups the end of the humerus and rotates around the end of the humerus like a hinge.

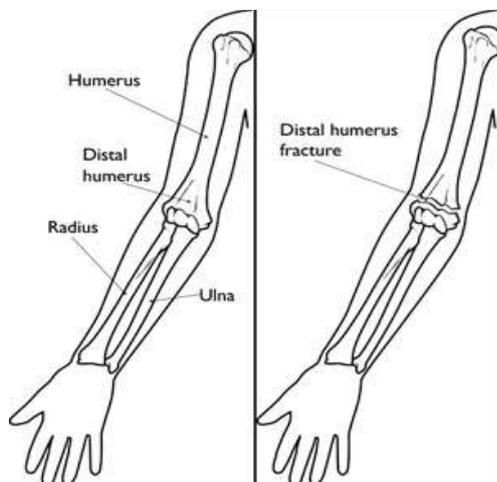


Figure 1: A distal humerus fracture: type of elbow fracture



Figure 2: The elbow is made up of parts of all three bones in the arm

a) Distal humerus

The distal humerus is the part of the humerus that sits within the cup of the ulna, allowing the ulna to move around it. This is elbow motion.

The distal humerus is able to be felt beneath the skin as a prominent bone, both on the inside of the elbow above the funny bone (the ulnar nerve) and on the outside of the elbow.

Upper part of the actual elbow joint makes up by the distal humerus. When it is broken, it can make elbow motion difficult or impossible.



Figure 3: Distal humerus to break into several pieces

It is common for distal humerus to break into several pieces. This type of fracture is called comminuted.

Distal humerus fracture is occurs in distal region when there is a break anywhere within the distal region or at the lower end of the humerus. Distal humerus fractures are fairly uncommon. It may occur in an isolated manner (it means that there is no other injuries), but can also be a part of a more complex elbow injury.

b) Doctor physical examination

Discussion about patient any medical history about fracture as well as any kind of symptoms, doctor will perform a careful examination about arm to determine the extent of the injury. Examinations of patient consist of:

1. Tenderness
2. Swelling
3. Bruising
4. Limited movement

During examination or observation if hand color changes it indication that circulation has been affected. Also examination for checking of whether any damage to the nerves or blood vessels.

II. TESTS

The most common and widely available diagnostic imaging technique is X ray. X-rays create images of dense structures, like bone. They can easily show whether a bone is intact or broken anywhere. To determine if a fracture has occurred, an x-ray of the elbow will be taken.



Figure 4: (Left) An x-ray of a healthy elbow & (Right) In this x-ray, the distal humerus fracture is severely displaced (out of place)

Depending on the patient's injuries, it may take x-rays of the upper arm, forearm, shoulder, wrist, to identify more injuries, like other fractures or dislocations.

III. PROCEDURE FOR ELBOW JOINT FRACTURE

Process to be carried out to get compression plate of specific patient:

1. Fracture CT scan: making of CT scan of fracture hand and opposite hand.
2. Opposite hand distal humerus 3D model: preparation of 3D model of opposite hand of fracture from CT scan images. Mimicc software will directly convert all CT scan image to 3D modeling.
3. Modeling of anatomical plate: by analyzing fracture prepare anatomical plate fix to suite in bones. Also this will helpful for finding the places where to make holes for screwing.
4. Rapid prototyping of plate: at the last prepare plate.
5. Surgery: finally for the implementation.

a) Compression plate

Following are the dimensions which are preferably used in the compression plate:

1. Thickness: 3.5mm to 4.5mm
2. Width: 1.5inches
3. Length: 10cm



Figure 5: (Left) Preoperative x-ray shows a displaced distal humerus fracture (arrow) & (Right) The fracture has been put back into alignment and held in place with metal screws and plates

V. CONCLUSIONS

Complex distal humeral fractures should be assessed primarily for the reliability with which they can be reconstructed with osteosynthesis. When osteosynthesis is not considered to be feasible then total elbow arthroplasty can be considered. This happens in specific patients who are physiologically older. This is recommendation for total elbow arthroplasty for the treatment of an acute distal humeral fracture.

As per the practitioner most patients can return to their normal activities within about 6 months. Although x-rays shows that the fracture healed completely but in many patients report says that they still have limitations in elbow movement. So, recovering strength in arm might takes longer than might be expected that sometimes up to 6 months or more.

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I **Pramod Wadate** working as Assistant Professor at Dr.D.Y.Patil School of Engineering & Technology, Pune. My working area interest is in the field of rapid prototyping, biomechanical engineering. From 2009, I worked in Rapid Prototyping afterword with the guidance of senior professors and researcher I started to do study in biomechanical engineering. For this I visited to various manufacturing industry of bone implant and understand process to be carryout.

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