# MASON II FRACTURES WITH THREE MILLIMETER DISPLACEMENT REQUIRE REDUCTION

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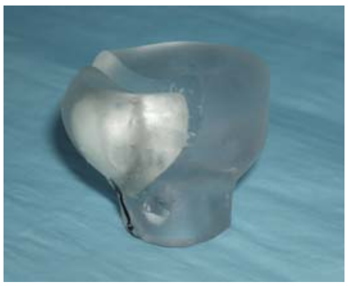
## INTRODUCTION

Open questions remain in the treatment of radial head fractures; in particular, the severity of Mason II fractures requiring operative treatment remains uncertain. Current practice suggests that any Mason II fracture with a displacement of greater than 2 mm requires operative treatment because of deficits in the range of motion, but little evidence documents this thinking. Thus, if a fracture displacement of greater than 2mm does not cause a range of motion deficit, the treatment rationale will require further examination. The Biomechanics Laboratory at Allegheny General has developed the capability of replacing the native radial head with morphometrically correct plastic models. Furthermore, these radial head models can include anatomically appropriate Mason II fracture fragments that can be adjusted to replicate fragment displacements from 1 to 4 mm with or without periosteal attachment. The current research first tested pronation/supination motion with the native radial head, followed by tests of three radial head fracture models with 3 mm displaced fragments. The null hypothesis was that no kinematic differences in pronation/supination would occur.

## METHODS

Five cadaveric elbows were tested in a physiologic elbow simulator to study blockage of pronation/supination after Mason II fractures. The simulator applied loads through the tendons of the five major muscles crossing the elbow and operated under servocontrol to actuate the elbow in any combination of pronation/supination and flexion/extension. Load cells monitored all actuation forces, an inclinometer measured flexion angle and a potentiometer quantified pronation - supination.

Radial heads for the recreation of Mason II fractures were formed from CT scans. Using software (Mimics, Materialise Inc.), the radial head was segmented, including the cartilage. The image was imported into SolidWorks (Dassault Sytemes) for manipulation and placement of the virtual fractures. Fracture fragments consisting of one-third of the head and extending past the distal border of the lateral cartilaginous surface were split from the head every 120 degrees around the circumference. Teeth formed on the mating fracture surfaces ensured that the fragment could be positioned 0 – 4 mm distal to the foveal surface and held in place.(s. Figure) A small screw, covered by bone wax after its insertion, held the fragment in place. The three virtual heads (one for each 120 degree increment of fracture location) were then fabricated in a rapid prototyping machine.



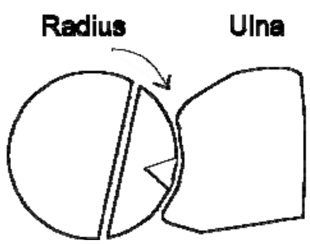
*Radial head from rapid prototyping machine with displaced fragment*

To replace the native head with an anatomically correct plastic part and preserve the functional native anatomy, a longitudinal osteotomy to remove the lateral half of the distal humerus was performed. The osteotomy extended six centimeters proximally from the lateral border of the trochlear groove. This osteotomy preserved the annular ligament. The osteotomy fragment was returned to its original position by two 2.5 mm screws inserted through lateral-medial holes drilled prior to the osteotomy.

To mount the plastic head in place of the native head, the neck of the radial head fragment included a hole aligned with the canal of the radius for insertion of a short, stepped shaft. A small cross-lock pin held the shaft to the radial head. The native head was removed, carefully identifying its orientation and length, using the surface of the saw cut to assist in placement. The plastic head with the short shaft was inserted into the bone cement-filled canal of the native radius in the exact position as the native head, preserving the original length. After the bone cement set and closure of the osteotomy site, the specimen was ready for testing.

Two types of Mason II fracture were examined. First, a three millimeter displaced fracture that had healed and united was modeled and tested. The fragment was displaced 3 mm, with the rotation constrained by the teeth on its face, and fixed to the radial head with the screw. Second, the experiment modeled and tested a three millimeter displaced fracture that was held in place by incompletely fractured bone and a distal slip of the periosteum. The periosteal fracture model introduced a gap between the fragment and the radial head body by inclusion of a 1 mm spacer over a loosely tightened screw holding the fragment to the head. To model the periosteal attachment, the fragment was also held by a 4-0 suture looped through the fragment's screw hole and tied to the distal rim of the fragment through a 1.8 mm hole.

Fracture sites 120 degrees apart were tested in the five elbows. The first fragment was located just proximal to the biceps tuberosity. The triangle in the accompanying figure shows the orientation of a fragment relative to the tuberosity.



*Circumferential location of the fracture*

Before replacing the radial head, each elbow was first mounted in the simulator for testing of pronation/supination of the native case. The simulator held the humerus in a clamp while control algorithms caused the forearm to move. The same algorithms worked on the native and the fracture model cases so that identical conditions existed for all tests. The elbow was held at 90 degrees of flexion by the brachialis with a low level of triceps co-contraction. Pronation then occurred with a maximum of 66 Newtons applied to the pronator teres, followed by supination with a maximum of 66 Newtons load applied to the biceps. The test began at neutral, fully pronated, then fully supinated, fully pronated and finally returned to neutral. Three trials of each test were performed. If the load reached 66 Newtons, movement in the current direction ceased, the direction of movement was reversed and the cycle continued until completed.

After testing the native case, the elbow was removed from the simulator, the native head was excised and a model head with no displacement was inserted in order to determine if use of the model itself created a kinematic deficit. The periosteal models were then tested. Finally, the elbow was again dismounted from the simulator, and the models with only the 3 mm displacement were tested. Three trials were performed for all cases.

**RESULTS AND DISCUSSION**

Kinematic deficits resulted in three elbows. In the three elbows, the average loss of motion was 30 degrees, with supination in two elbows in and pronation in one. In one supination case, an increase in force overcame catching that had occurred. The capitellum was scuffed in two cases. Causes of the deficit were abutment of the fracture face on the ulnar notch and catching on the capitellum.

That three out of five showed functional loss indicates that a fracture with a 3 mm fragment displacement requires surgical intervention. Although it is unclear whether any repair without open reduction is possible, conservative treatment with immobilization might not result in complete functional recover. More specimens and other fracture displacements should be tested to further elucidate the consequences of these fractures.

**ACKNOWLEDGEMENTS**

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