



Preventing Proximal Radio-Ulnar Joint Screw Penetration during Coronoid Fracture Fixation: A 3D-Digital Modeling and Cadaver Study

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► ABSTRACT

Objective: Intra-articular screw penetration is a probable complication of coronoid fracture fixation. The present study aimed to determine the best radiography technique for visualizing the proximal radioulnar joint (PRUJ) space. Moreover, it aimed to determine the safe angle and length of the screw to avoid PRUJ penetration during coronoid fracture fixation.

Methods: The Mimics software was used to construct a three-dimensional model of a healthy man's forearm from a computer tomography scan. It was analyzed using the Solidworks software to determine the X-ray angle that clearly showed the PRUJ space to detect penetration of screws from the coronoid process into the PRUJ and determine the maximum screw angle and length that could be used without intra-articular penetration. To verify these findings, a cadaveric study combined with radiographs was conducted.

Results: To visualize PRUJ space, the optimal X-ray angle was 13° lateral to the perpendicular line when the forearm was positioned at full supination. If the coronoid process was segmented into zones 1 (closest to the radioulnar joint) to 4 (farthest from the joint), the screw could only be inserted at a right angle in zone 1. In zones 2, 3, and 4, inclination angles less than 15, 35, and 60 would prevent intra-articular penetration, respectively.

Conclusions: The X-rays could visualize the PRUJ space with an anteroposterior radiograph at an angle of 13° ulnar deviation from the perpendicular plane. During coronoid process fracture fixation, shorter screws with less lateral inclination were safer when inserting screws in the zones of the coronoid process adjacent to the PRUJ.

Keywords: Screw placement, Coronoid process, Cadaver, Elbow, Computer simulation, Radiography.

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This study simulated ORIF of coronoid fixation using screws with anteroposterior direct and not posteroanterior directed screws. As a result, the recommended length and angles might not be applicable to posteroanterior directed screws. However, the suggested X-ray beam is still helpful for inspecting the PRUJ for screw penetration. The present 3D digital and cadaver models belonged to adult males. Previous studies found that the coronoid process dimensions were different between men and women [19]. Therefore, the results of this study cannot be generalized to the female and pediatric populations. Accordingly, since this study does not consider anatomical variations, these findings might not be generalizable to different body types or ethnicities. Finally, the present results were produced with the prerequisite that the screw had no deviation distally or proximally (angle between the screw and the transverse plane=0°), and that the forearm was positioned in complete supination. However, in practice, surgeons attempted to insert the screw perpendicular to the fracture plane. Since the fracture plane might face any direction, the surgeon might prefer to insert the screws with a more proximal or distal angle. Furthermore, during the procedure, the limb was manipulated and repositioned frequently, which made it difficult for the surgeon to determine the angles. Besides, it was not possible to assess which method of screw fixation could provide a more stable fixation. Thus, we just focused on the angle of

screws and their length.

The optimal X-ray angle for assessing the PRUJ was 13° ulnar deviation of the X-ray beam when the forearm was in complete supination. When fixing a coronoid process fracture, shorter screws with less lateral inclination should be utilized in the coronoid process zones closest to the radio-ulnar joint.

Declaration

Ethical approval for study: The investigation was approved by the local ethics committee (code: IR.SUMS.MED.REC.1401.177).

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