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The Mooji Effect of "Osborne-Cotterill Lesion" New Approach to Concept

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1. Introduction

Elbow dislocation is a common injury that in majority of cases is treated conservatively with good outcomes [1, 2]. Nevertheless, there are certain characteristics that should be considered to optimize outcomes and prevent complications, mainly instability and pain [3]. Some of the risk factors are not under control like laxity, age and some are related to sport activities [4]. But what concerns us is the injury character, meaning if there is an impaction injury to the capitellum or fracture of the anterior lip of the radius that otherwise would be treated conservatively. We promote further discerning of these patterns and analyzing it to prevent residual instability that could eventually affect quality of life. In the literature "Osborne-Cotterill Lesion" is defined as a depression fracture in the capitellum [5, 6]. Subsequent literature tried to address this injury and relate the depression in the capitellum to instability and described the depression as an injury caused by radial head dislocation impinging upon the capitellum and causing a crater [7]. Furthermore, a question was asked repeatedly relating to the importance of this lesion regarding instability raising the question whether part of the instability is related to the Lateral Ulnar Collateral Ligament (LUCL) only or also to the osseus defect [8]. Some authors tried to answer this question with anecdotal cases, case series or biomechanically in laboratory conditions [9-12]. What is interesting is that description of the fragment is nearly always posterior and lateral and not central in the capitellum which indicates that the fragment is produced when the radial head dislocates laterally and posteriorly and hits the capitellum at this specific location in a predicted manner with the same mechanism [6, 7]. The lesion could cause engagement of the radial head, and the radial head may be dislocated and stuck in that position necessitating open reduction [13]. As the process of dislocation could lead to "Osborne-Cotterill Lesion" with impaction injury, we suggest calling the engagement process of the radial head when it slips in that lesion The "Mooji effect". We assign importance to this effect clinically and biomechanically and suggest addressing it in a tailored and specific manner. Otherwise, even with surgical intervention that intends to reanimate LUCL with re-insertion or reconstruction, the Mooji effect will lead to instability translated into dislocation or limited range of motion to prevent engagement [11]. In this series we represent a different approach to treat this enigmatic problem. We suggest bone grafting the "Osborne-Cotterill Lesion" and adding a posterior plate to lock the graft and to further thicken the barrier for dislocation. We will demonstrate this strategy with the help of two cases and present a simple algorithm to help decide when to address "Osborne-Cotterill Lesion" surgically.

1.1. The Critical point for "Mooji effect": The anatomy of the radio-capitellar joint is intriguing; There is a match between the radius of radial head and the radius of the capitellum as this joint perform a 3D motion- Flexion-extension, pro-supination and translation [14]. Extension could be accompanied by supination movement and translation at the same time. For the radial head to dislocate, it must pass a critical point at the posterior edge of the capitellum. Passing that point it could relocate back or engage a shallow depression in the capitellum. To decide where this critical point is, we make several hypothetical points.

1.The diameter of the capitellum is the same diameter of the radial head [15].

2. The dislocation includes a translation of the radial head and not only a pendulum movement of the radial head against the capitellum [16].

3.The capitellum functional surface is inclined in average 45 degrees relative to the humerus [17].

4.The hyaline cartilage of the capitellum-functioning surface- covers 180 degrees (half of a full sphere).

5.The radial head has intrinsic translation movement of 1 radian up to the bisecting point of the capitellum when the posterior capsule is injured (following fracture or dislocation) [12, 18].

These assumptions could be partly referred from literature and partly from observation and mechanical deduction. Based on these assumptions we build the safe zone that indicates the distance the radial head could travel before it passes the critical point. In full extension the posterior edge of the radial head passes this critical point (Figure 1). This is because the capitellum being a half sphere is anteriorly sloped. Because of the slope of the capitellum, the critical point forms a 45-degree angle between the center of the capitellum and a vertical line parallel to the humerus or horizontal line parallel to the radial head in neutral full extension.

We define "α" angle as 2 radians (114.6 degrees) of the capitellar sphere equal to diameter of the radial head which is the distance the anterior edge of the radius needs to pass before dislocating when it is in full extension. Form "α" we must take out "β" which represents the point where the shallow edge of the capitellum starts. To infer "β" we make a basic geometric calculation based on the above assumptions, and we deduce that "β" is equal to 12 degrees. Now we calculate the residual distance the radial head must make to reach the critical point. 12 degrees is 0.2 radians leaving 1.8 radians for the radius to make from the original 2 radians. If we take the translation potential of the radial head following injury to the posterior capsule, this leaves us with 0.8 radians up to the critical point "γ" angle. 0.8 radian is the safe zone. This distance equals roughly a quarter of the functioning capitellum surface (Figure 2).

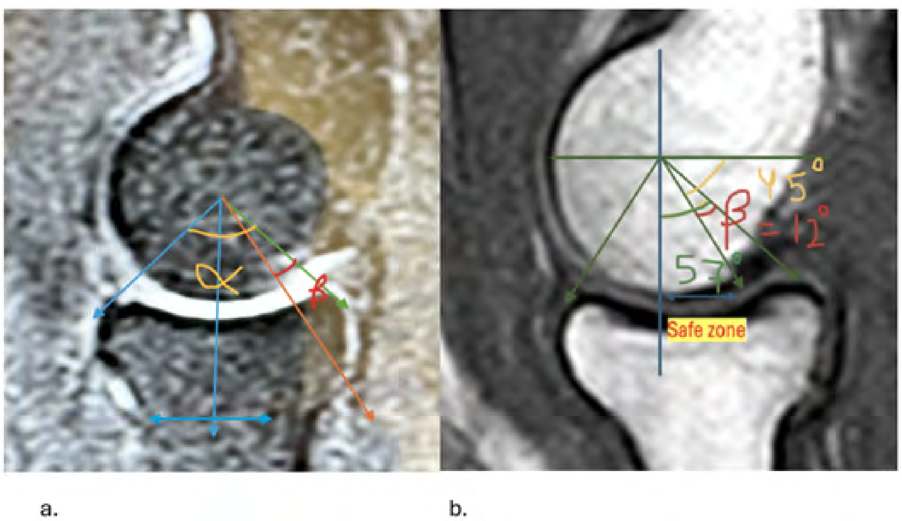

Figure 1: a. Sagittal MRI cut for the capittelum and the radial head in extension. The "α" angle represent 2 radians and the orange arrow cross at the critical point. b. Sagittal CT cut that demonstrate the safe zone wich equals roughly a quarter of the functional capitellar surface. "γ" angle is the angle between the blue arrow and orange arrow.

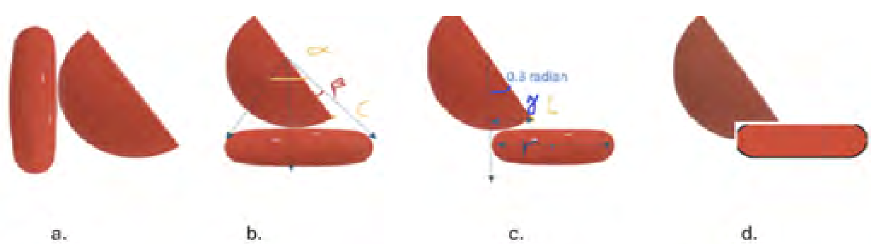

Figure 2: A simple 2D model for Radiocapitellar joint motion. a. 90 degrees elbow flexion. b. The elbow in neutral extension. c. one radian translation of the radial head following injury. d. Following "Osborne-Cotterill Lesion" of more than 0.8 radian, the radial head engages the lesion- "Mooji effect".

1.2. This safe zone could be breached in several scenarios

1.Fracture of the anterior articular surface of the radial head leaving less safe zone.

2.Classic "Osborne-Cotterill Lesion" with encroachment of the depression in the capitellum more anteriorly- critical point. This could potentially lead to a large "β" angle. If "β"is equal to 57 degrees, then there is no safe zone, then, full extension, and supination with 1 radian translation will cause an engagement of the radial head on the capitellar depression- "Mooji effect".

3.A combination between radial head fracture and "Osborne-Coterill Lesion". If we lose a third of the anterior radial head (0.66 radian) then, this will only leave little room for engagement (0.14 radian) [19, 20].

4.Posterior comminution fracture of the capitellum or shear fracture of the capitellum.

2. First Case

An 18-year-old patient who fell from a bicycle injured his right elbow. He was diagnosed with fracture dislocation of the elbow (Figure 3.a). The elbow was reduced in the ER and a cast was applied (Figure 3.b). A subsequent CT with 3D reconstruction revealed olecranon fracture with avulsion fracture of the Lateral Ulnar Collateral Ligament (LUCL) and a posterior depression of the capitellum – "Osborne-Cotterill Lesion" (Figure 4.). The patient was offered surgery to fixate the fracture and stabilize the elbow joint. A posterior approach was utilized first, and the olecranon fracture was reduced and stabilized with locked plate (Figure 5.a.). Following this, a second lateral elbow approach with Kocher extension was utilized. LUCL was avulsed from its origin and there was a depression fracture on the posterior edge of the capitellum. At this stage, we feared that mere ligament stabilization will not be enough to prevent radial head engagement, thus, we proceeded to fill the depression with bone graft and a plate was contoured and utilized to stabilize the construct; Two anchors were used to reattach the LUCL (Figure 5. b.). Following the surgery, the elbow was splinted for a week, and then substituted with a dynamic elbow splint to allow early range of motion (Figure 6). 8 weeks following the surgery, the patient had full range of motion and was able to return fully to prior level of activities (Figure 7).

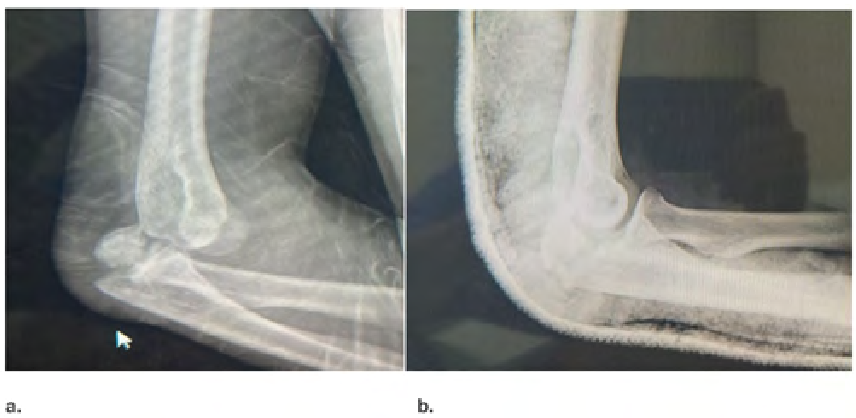

Figure 3: X-rays of the patient. a. fracture dislocation of right elbow. B. reduced elbow with posterior splint

Figure 4: 3D reconstruction of the injury following reduction

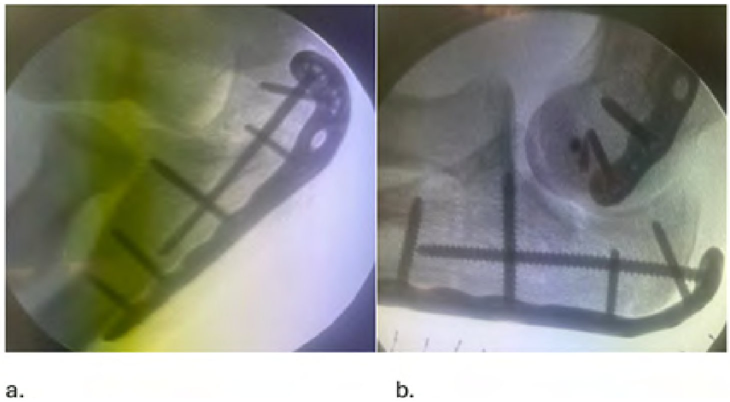

Figure 5.a: Fluoroscopic image following olecranon reduction and fixation with contoured plate. The elbow is unstable at this juncture. B. The "Osborne-Cotterill Lesion" was filled with bone graft and stabilized with contoured plate. Two anchors were used to reattach the LUCL. Following the procedure the elbow was stable in full range of motion.

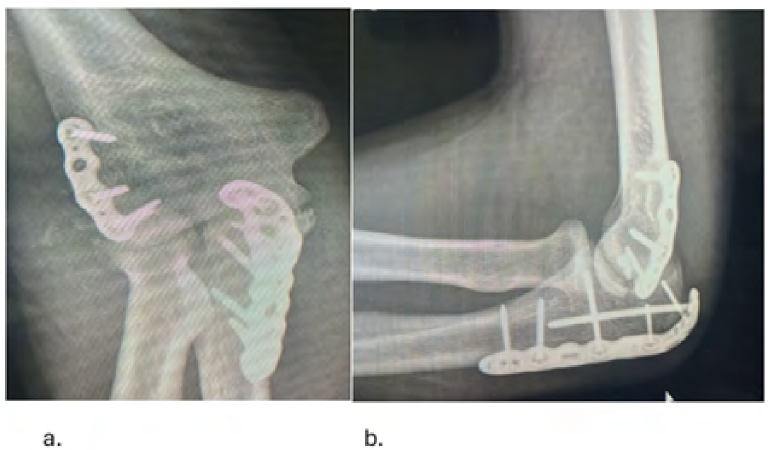

Figure 6: X-ray images one week following the surgery. a. AP X-ray showing the posterior plate at the distal lateral part of the humerus. b. Lateral X-ray demonstrating the distal edge of the plate increasing the safe zone.

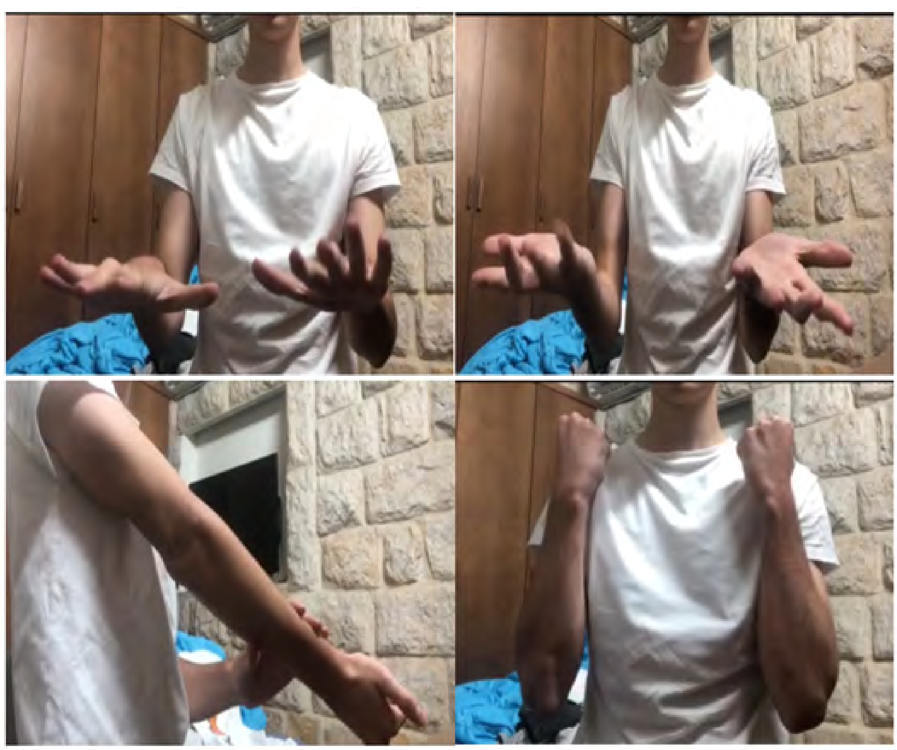

Figure 7: The patient after few weeks with full range of motion including full stable extension with supination.

3.The Second Case

A 45-year-old patient who fell from a ladder injured his left elbow. In the ER he was diagnosed with fracture of the capitellum and trochlea. A CT was done with 3D reconstruction to further elucidate the fracture and plan intervention (Figure 8). The 3D reconstruction revealed a posterior capitellar comminution (Figure 9). A temporary splint was utilized for pain control and the patient was admitted for surgical intervention. The next day the patient underwent a surgery with lateral elbow approach and distal Kocher extension. The proximal incision with partial brachioradialis release facilitated a deeper window for the trochlea. The trochlea was addressed first followed by the capitellum with reduction and provisional fixation with Kirchner wires and then with canulated screws in the sagittal and coronal plains to maximize purchase and stability. A posterior fracture of the capitellar wall with comminution distally led us to add a posterior humeral plate that was advanced distally as possible close to the critical point to add stability and counteract potential "Mooji effect" (Figure 10). The patient was allowed early supervised range of motion 3 days following the surgery. The patient was discharged after 5 days to ambulatory rehabilitation and was lost to follow-up.

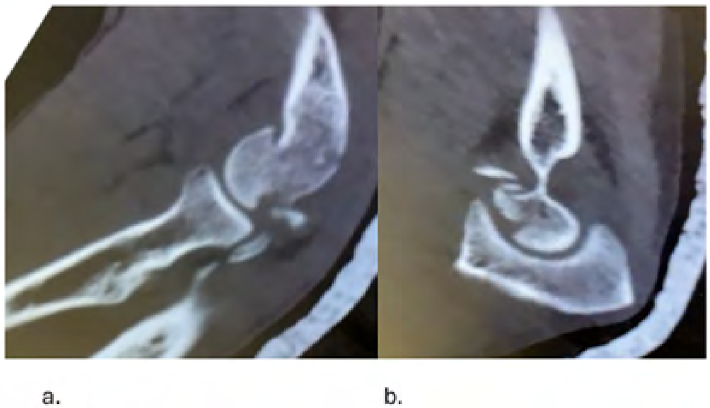

Figure 8: CT of the left elbow of the 2nd patient. a. The cut demonstrates the posterior lesion in the capitellum laterally. b. more medial cut shows the trochlear fracture.

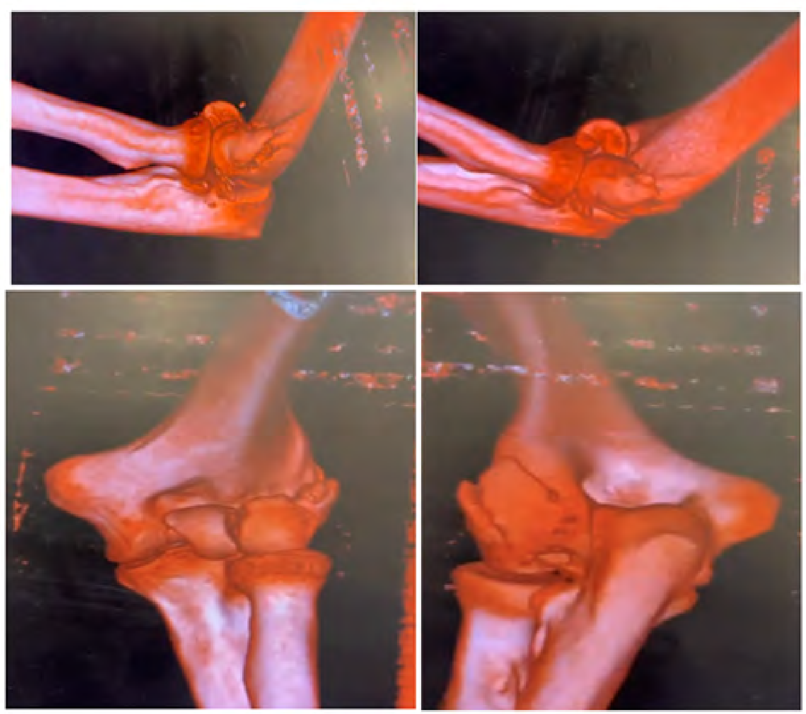

Figure 9: 3D reconstruction of the fracture involvong capitellum and trochlea with posterior comminution of trochlea inducing "Osborne-Cotterill Like -Lesion".

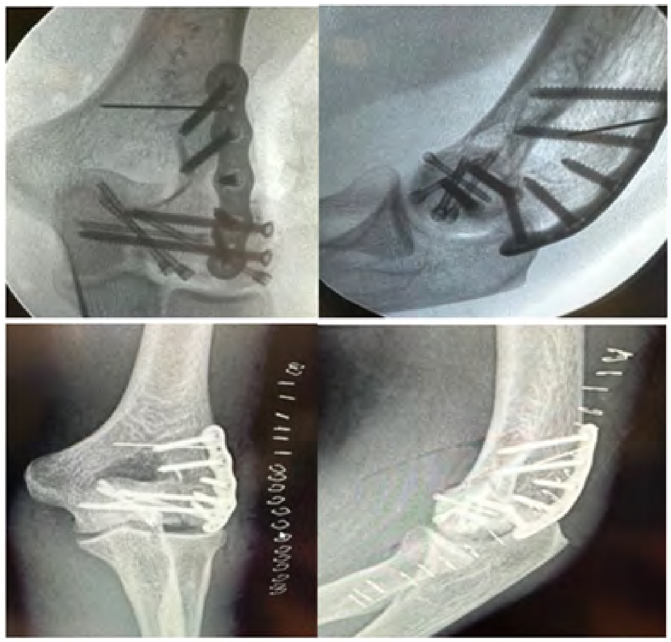

Figure 10: Flurosocopic and X-ray images of the patient left elbow following reduction and fixation with cannulated screws for the coronal fracture of the trochlea and capitellum and posterior contoured plate for the posterior comminution neutralizing the "Mooji effect".

4. Discussion

In this article we try to explore further the so called "Osborne-Cotterill Lesion". We try to understand its impact and describe the best approach to address it to minimize complications and maximizes outcome. We define the critical point of the capitellum as the most anterior point the radial head can reach before it dislocates and potentially engages a shallow area posteriorly. The process of engagement is called "Mooji effect" in reference to the byname of the author. The radial head can translate posteriorly up to the critical point. we figure the distance to be 1.8 times the radius of the capitellum. We assign the radial head a freedom of one radius translation in extreme position of extension and supination in the context of injury to the posterior capsule, leaving a mere 0.8 radius which is the safe zone. Based on our assumptions, the critical area can move further anteriorly encroaching on the safe zone up to a point that the radial head is inherently unstable in functional positions. This could be attributed to depression fracture as the radial head dislocates and imprints upon the capitellum or from comminuted fracture. We suggest that when the capitellum loses 0.25 of its posterior cartilage, then an osseous reconstruction is mandatory. When there is an additional fracture in the anterior radial head or the patient has joint laxity, then more liberal approach is warranted to address "Osborne-Cotterill Lesion". While several authors introduced variant approaches to enhance osseus stability in the context of posterolateral instability, including reduction [10], bone grafting [13], osteochondral allograft transplantation [21], and even Prosthetic resurfacing [22], here we suggest a simple practical approach that helps reach instability with filling the defect with bone graft and utilizing a posterior plate to the capitellum to countereffect the "Mooji effect". Our concept aligns with other biomechanical study that referred to radial head translation following posterolateral capsule injury that stated about 11 mm translation following injury to LUCL+ posterior capsule [12]. This in fact is half of the mean radial head diameter (one radian) in accordance with our assumption [23]. The plate not only protect the reduction or the lock bone graft, but its bulk and position prevent mechanically the "Mooji effect" and the radial head must translate further to skip the plate which increase the safe zone. This step should be contemplated whenever "Osborne-Cotterill Lesion" is found in the context of lateral elbow dislocation, fracture dislocation or complex elbow fractures. Other elements of the injury should be addressed including fractures and ligament avulsions. This will minimize the freedom of posterior translation of the radial head.

Our theory resembles much the "On-Track/Off-Track" paradigm introduced by Itoi and associates [24, 25], which discusses stability concept of the shoulder in the context of osseous defect in the glenoid and hill-Sachs lesion in the humeral head. Abduction and external rotation in the shoulder parallels extension and supination in the elbow and engagement happens easily with bipolar injury to the glenoid and the humerus as is the matter when the radial head loses anterior lip and the critical point of the capitellum moves anteriorly leading to "Mooji effect". While off track lesions are treated with remplissage to the humeral head or Latarjet procedure to the glenoid [26], the "Osborne-Cotterill Lesion" leading to the "Mooji effect" is treated with bone graft and plating and the radial head fracture is either reduced and fixated or replaced. Interestingly, loss of more than 25% of the glenoid is treated with bony procedure like Latarjet procedure [26]. Other scenarios where we could encounter the "Mooji effect" and needs to be addressed is capitellar fractures with posterior comminution. This could happen in the context of shear fractures of the capitellum elucidated through the Dubberley's classification of capitellar and/or trochlear fractures, specifically type B [27]. The posterior comminution, even with articular reduction could potentially lead to posterior engagement eventually, and it is addressed with bone grafting [28]; Furthermore, outcomes are inferior to type A without posterior comminution [29]. This is why it is better treated with additional posterior locked plate [30]. Another interesting option is shear capitellar fracture that leaves the radius engaged in without dislocation (Figure 11).

Figure 11: X-ray that demonstrates Capitellar fracture. (Bryan and Morrey Type I). The radial head is engaged in the fracture site.

5. Conclusion

We introduce an intuitive system to analyse the safe zone and help build a practical plan when "Osborne-Cotterill Lesion" is recognized. We encourage using CT scan in the sagittal plain and building 3D model to find the the anterior border of the lesion and see whether it encroaches upon the critical point and minimize the safe zone and beyond. If the safe zone is compromised and there is an accompanying fracture int the radial head further minimizing the room for maneuver, then moving back the critical zone is recommended by means of grafting and plating and not only ligament stabilization or reconstruction. We assign 25% safe zone and if it is violated then a bony procedure including plating is recommended. Our study is not without shortcomings. It only demonstrates two cases with one case lost to follow-up. Our recommendations are based on multiple hypotheses that needs to be further explored in laboratory conditions and clinical set-up. More evidence is needed to collaborate our assumptions. But taking into consideration the rarity of this injury and the scarce literature that is based on case reports and small series, then we strongly advise re-evaluating the "Osborne-Cotterill Lesion" and adopting the concept of "Mooji effect" when treating similar injuries.

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