CASE REPORT

An unprecedented case: Salter Harris II Gartland modified IV fracture of the humeral palette with metaphyseal fragment olecranon fossa

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Abstract

Background. The Salter-Harris II fracture is the most common transphyseal fracture of all types of fractures, per-total and for each bone extremity that has a growth cartilage. This type of fracture rarely occurs in the humeral palette and the metaphyseal fragment is located laterally or medially. No cases with ventral or dorsal metaphyseal fragment have been described.
Purpose. To bring into notice a fracture, type Salter-Harris II, with posterior metaphyseal fragment, represented by a posterior corticospongiosis lysereum(thickening) and the olecranon fossa, associated with periosteal rupture and soft tissue interposition.
Study design: Case report
Methods: A 9-year-old patient shows signs of traumatic injury, as a result of a direct impact on the right elbow. After a radiological examination, the diagnosis of Gartland type III supracondylar fracture is established, a closed reduction is practiced and it is immobilized in a plaster cast. The radiological control after the orthopedic reduction highlighted an unsatisfactory reduction. A surgery and an open reduction and internal fixing in "double X" were performed.
Results: The preoperative diagnosis of Salter- Harris II fracture, with posterior Holland fragment, was made with difficulty and may be a surprise on intraoperative exploration.
Open anatomical reduction and the fixation in "double X" allowed a firm synthesis of the fracture, verification of stability, intraoperatively, lack of mobilization in the plaster splint, starting recovery on the first postoperative day and full recovery of elbow mobility in 32 days.
Conclusions: Salter Harris type II fracture with posterior fragment dislocated by tilting, translation and asymmetric rotation, irreducible is operated by open reduction and internal fixation. The fixation in "double X" ensured a better stabilization and allowed the recovery of flexion and extension in 32 days from surgery.

Keywords: low distal transphyseal fracture of the humerus, modified Gartland classification, the Hollander sign present posteriorly, double- X fixation, sfety and fast recovery.

1. Introduction

The fractures of the humeral palette arouse a special interest due to the diversity of fracture types and especially, due to the high rate of complications, which can be generated by secondary displacements of orthopedic or surgical treatment. Complications followed by elbow ankylosis or Volkmann syndrome induces serious functional deficiencies, that can sometimes have mental side effects/responses.

The most common elbow injuries are supracondylar fractures. In countries with poor medical infrastructure and limited staff and resources, the humeral patella fractures in children under 16 are in the first place. In this context, the orthopedic treatment of fractures with surgery reccomendation leads to a large number of complications [1, 2]. Salter-Harris type II fractures are low fractures, infracondylar, transphyseal fractures and involves the growth cartilage. All Salter- Harris fractures are specific to children and occur in 15% of long bone fractures [3]. Type II fractures involves the growth cartilage and metaphysis: the epiphysis has attached a metaphyseal bone fragment located medially or laterally. This is the pattern of Salter-Harris fractures. Healing is fast and rarely has disturbances. Axial deviations occur mainly in the distal extremity of tibia and femur. No type II humeral palette fractures with ventral or dorsal fragment have been published or reported. It occurs more frequently after the age of 10 and occurs through a shearing mechanism. The physis under pressure can be damaged.

The presence of the metaphyseal fragment detected radiologically or imagistically is known under the eponym or sign of Thurstan Holland [4].

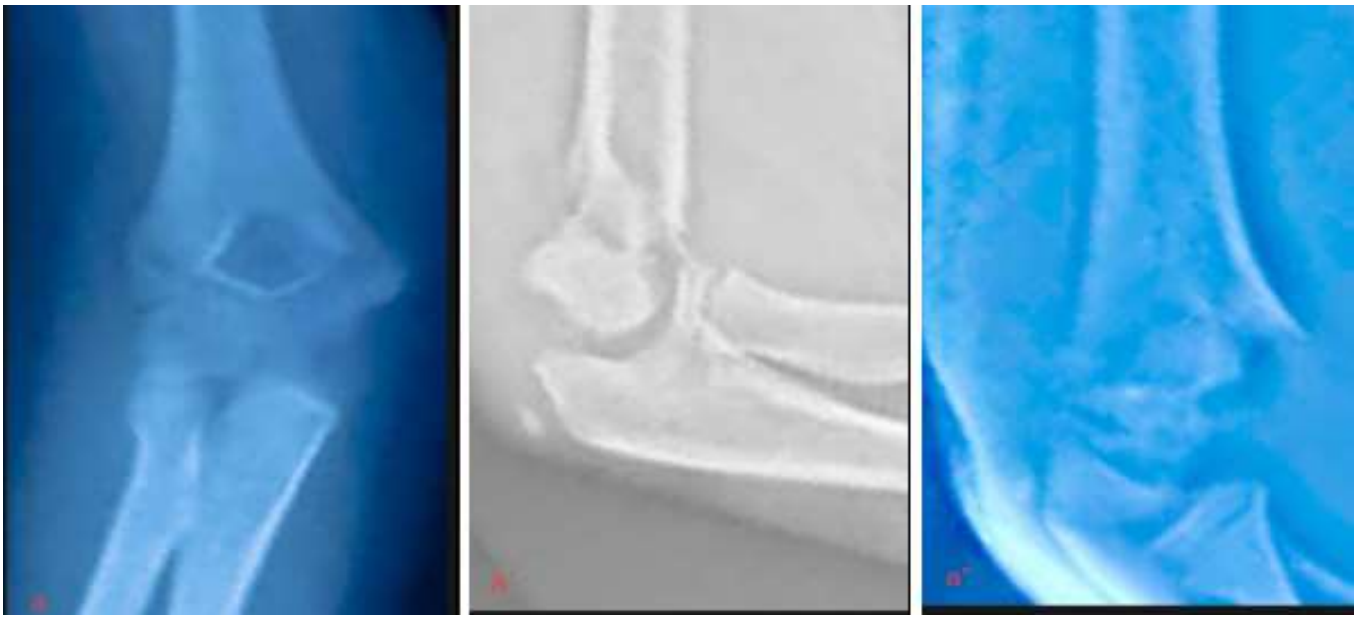
2. Case report

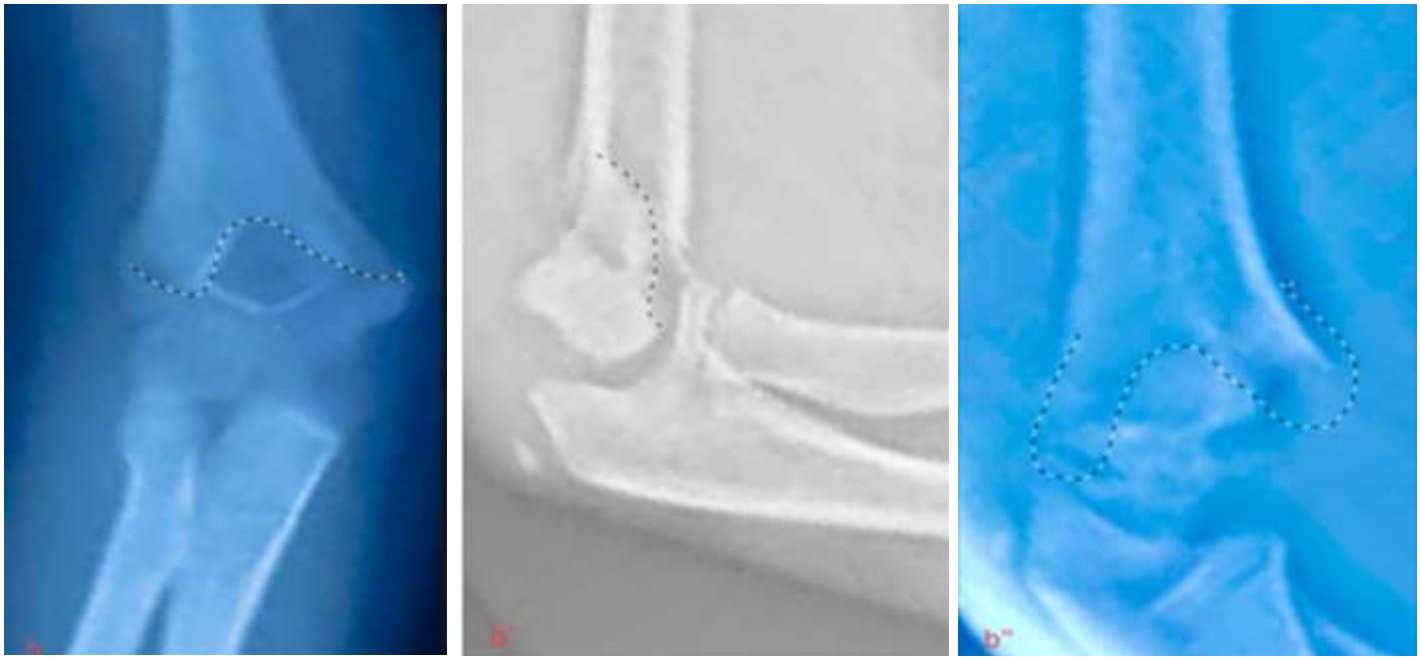
A 9-year-old overweight boy, weighing 41kg, suffered an unforeseen accident, as a result of a direct, high-intensity impact by falling from a hoverboard. Following the impact, he presented clinical lesions susceptible to an elbow fracture, radiologically confirmed, as a fracture of the distal extremity of the humerus type Gartland III. In case of emergency, in an Emergency Unit, the orthopedic reduction under general anesthesia and immobilization in the brachi-palmar plaster splint will be performed.

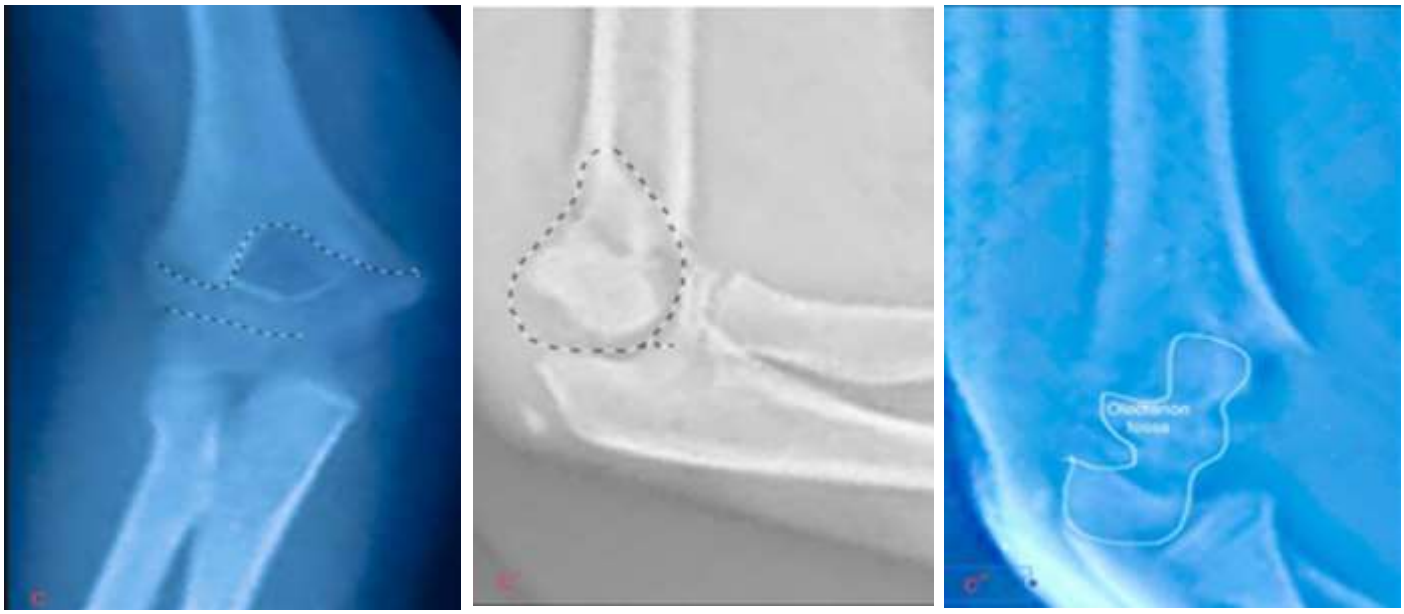
Evaluation under fluoroscopic control finds that the fracture is unstable. The X-Ray control, front and profile, highlights an axial replacement of the humeral palette (**fig. 1a-d and a'-d'**) from Gartland III position. The parents have requested another orthopedic consultation to confirm the surgery indication and to operate their child in a private medical unit.

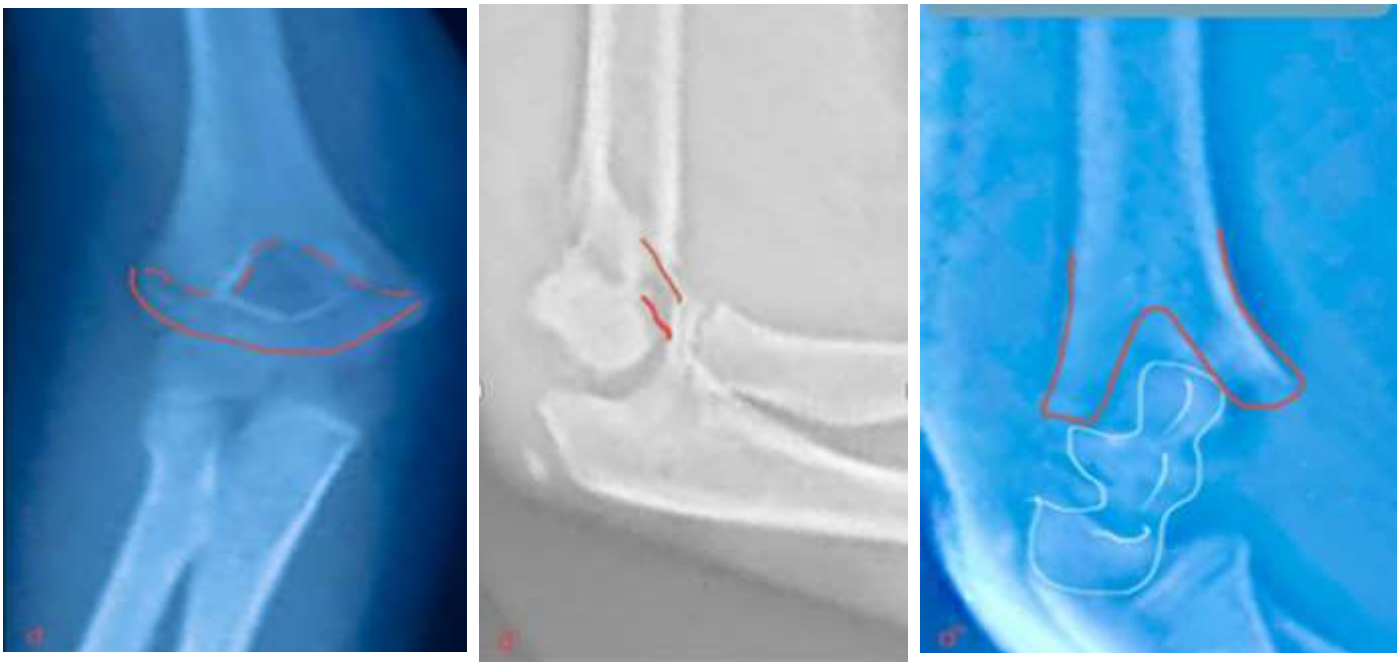
FIG. 1 Radiological images - frontal, profile and oblique incidence.
Frontal (coronal) radiography (a-d) shows indicative signs of minor and debatable relevance;
a) at the level of the columns, two radio- transparent fracture trajectories are identified, which have a discontinuity in the area of the olecranon fossa.
b) the fracture lines continue through a semicircular trajectory, that surrounds the olecranon fossa, proximally;
c) the radiotransparent linear area of the physis between the metaphysis and the ossification center of the capitelum isabsent (the ossification center of the trochlea did not appear);
d) the presence of the mentioned signs (and the union of their trajectories) makes us suspect a transphyseal fracture of the humeral palette.
The X-Ray profile (a'-d ') identifies:
a ') fractured bone fragment;
b ') the fracture trajectory is oblique from the posterior to the anterior;
c ') a metaphyseal fragment forms a common body with the metaphysis;
d') the trajectory of the fracture has a horizontal distal segment, that affects the growth cartilage.
Oblique X-Ray incidence (a " - d ");

a ") axially repositioned Garden III type fracture, is not reduced;
b ") the two columns have no contact with the epiphysis;
c ") The epiphysis has a fragment that "seems to be" the olecranian fossa;
d ") the three types of displacements appear: tilting, asymmetric rotation and translation.







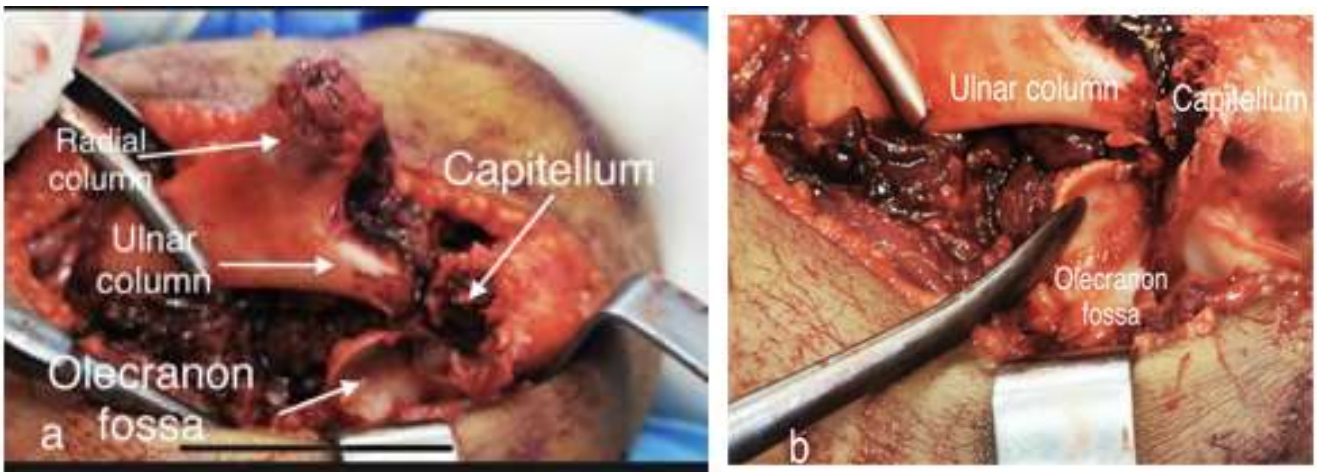


In order to have eloquent data for surgery, I performed an elbow angled X-Ray projection through plaster and I found the distal fragment of the palette displaced; tilted, rotated asymmetrically and translated (**fig.1 a"-d"**). After reconfirming the unsatisfactory reduction, the parents requested the surgery. The surgery was performed by Kohcher approach, followed by a rigorous dissection [5] that allowed a thorough exploration of the fracture.

The trajectory of the fracture was intraarticular. The hematoma present intraarticularly and the low placement of the fracture led to the separation of a small distal fragment. The

posterior periosteum was totaly torn and a pediculated portion that was joined by a fibro-adipose conglomerate was interfragmentary interpolated. At the proximal extremities of the two columns, radial and ulnar, were present at the exteriorization of the proximal fragment, and the proximal part of the fossa was missing (**fig. 2a**). According to all the theoretical knowledge and experience gained, the trajectory of the fracture should have passed through the fossa and be divided into two: a proximal part and a distal part.

FIG. 2 The proximal fragment has only the radial and ulnar columns. Between them there is a columnar incision; b) The olecranian fossa was avulsed and is attached to the epiphysis

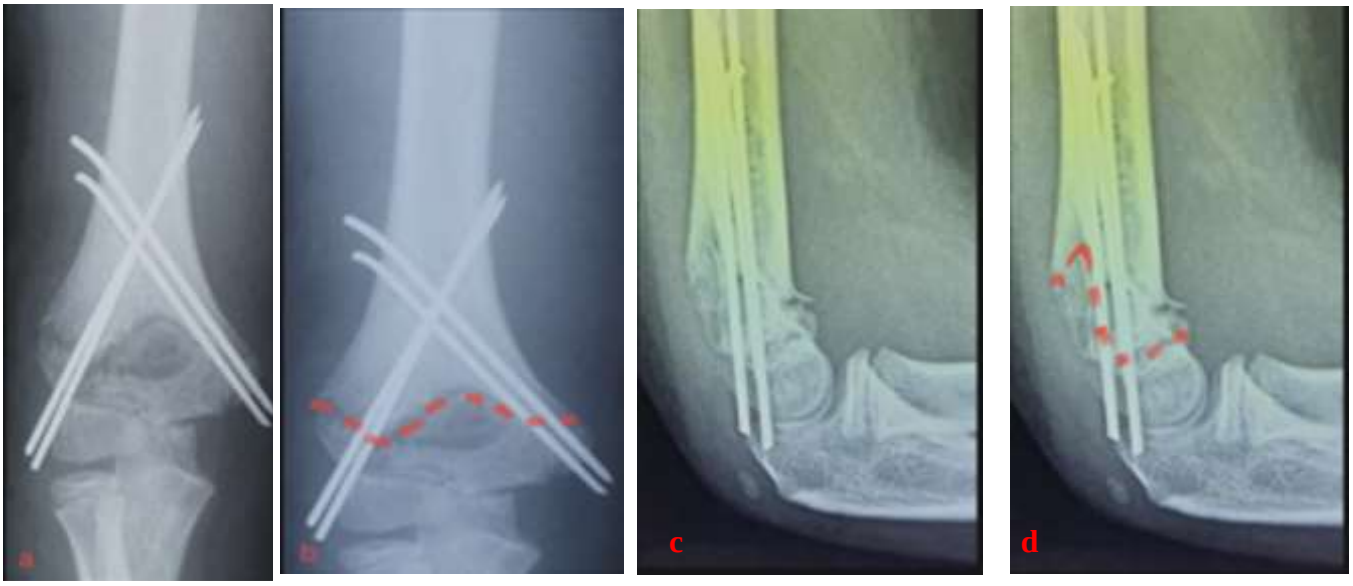


The fracture line was oblique from the dorsal to the ventral, descending distally to the level of the growth cartilage and had a small posterior metaphyseal lysereum with a height of about 0.5-0.7 cm, deep and with irregularities, it traversed the entire growth cartilage along its entire length, and the distal fragment had attached the olecranon fossa [**fig. 2b**].

The thickness of the physis, about 1.5 cm, was revealed about 1 cm. The orthopedic reduction test showed an unstable fracture type IIb Gartland IV modified, and the reduction maneuver was done very carefully, to avoid complete avulsion of the olecranon fossa.

An anatomical fracture reduction was possible and a, double X" osteosynthesis with wire (**fig. 3**) fixation to provide reduction safety and faster recovery. The stability was checked intraoperatively; in the flexion-extension and pronation-supination maneuvers in their full amplitude, there was no mobility in the outbreak, and the course was continuous without encountering resistance.

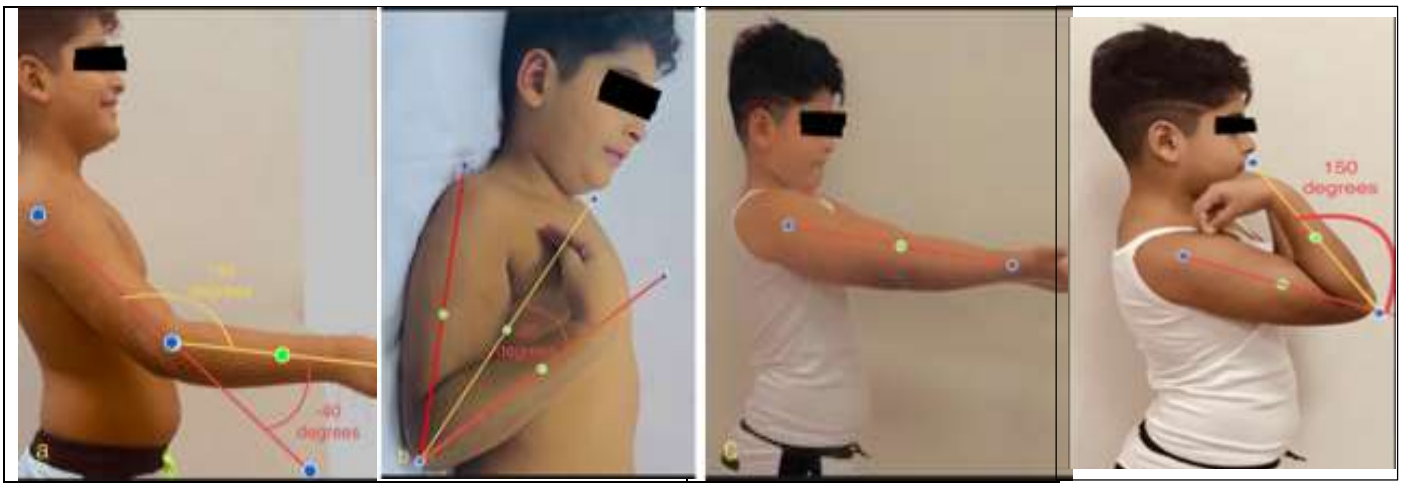
FIG. 3 Fracture osteosynthesis, in "double X".



The intervention lasts 45 minutes. After closing the wound, a dressing/bandage was applied and it was not immobilized in a plaster cast.

The recovery began at home, from the first postoperative day and the mother performed passive flexion and extension movements, up to the pain limit, for 7 days. Then, under supervision, he made active movements and at 15 days the recovery began in physiotherapy center for children. The total recovery of elbow mobility was obtained after 32 days [**fig. 4**]

FIG. 4 At 14 days after the operation a) the extension was limited by 40 degrees and b) the flexion by 20 degrees. At 32 days c) the extension was 180 degrees and d) the flexion 150 degrees.



3. Salter-Harris type II fractures

The essential characteristic of the Salter-Harris type 2 fracture, unlike type 1, is given by the presence of a metaphyseal fragment, found in continuity with the metaphysis through a segment of intact physis. The physis has an intact portion corresponding to the metaphyseal fragment and a free one portion with the interface of the provisional calcification zone detached from the metaphysis.

Injury to the physis in the free area is possible. The maximum incidence of this type of fracture occurs around the age of 11 years.

The metaphyseal fragment, highlighted radiologically, was considered a distinctive sign of the Salter-Harris type II fracture in 1929 by Thurstan Holland [6], and is known as the Holland sign. Routine radiological examination, in the antero-posterior and lateral incidence of Salter- Harris type II pattern fractures, clearly identifies the Holland sign.

In certain situations, when the fragment is located posteriorly, as in the case above, oblique incidents are also needed to highlight this sign or to reveal certain movements of the fragment: tilting, translation, or asymetric rotation.

The metaphyseal fragment can be big, medium or small. When the size of this fragment is small, the portion of the fractured physis is larger. Confirmation of the Salter-Harris II fracture is done in the healing phase with indications of the presence of subperiosteal callus and lack of transmetaphysis sclerosis on the radiological incidence made in parallel with the plan of the metaphyseal section, or in other words, only on one of the front or profile incidents. In the Salter-Harris type 1 fractures, trans-metaphyseal sclerosis occurs in all incidents, and the callus is absent immediately after healing.

Type II fracture is the most common fracture and represents 75% [7], of all types of Salter Harris fractures. It also has the highest incidence regardless of location. Paterson [8] individualizes 510 fractures Salter-Harris type II, 54%, after an epidemiological study done on 951 transphyseal fractures. The highest frequency was in the fingers; 243 of 510, 48%.

4. Discussion

The patient introduced in this study had a Garland type 3 displacement. He was diagnosed at the Emergency, after performing some X-Rays, frontal and profile, with supracondylar humerus fracture type Garden III and, after a temporary immobilization in the brachiopalmar plaster splint, he was hospitalized in the orthopedics ward.

The orthopedist attempted the orthopedic reduction under general anesthesia. Under fluoroscopic control, he found instability of the fracture after orthopedic reduction. In most cases of Gartland type III fractures, the fracture line passes through the olecranon fossa which has very thin walls and the two columns, radial and ulnar.

The instability of the fracture was confirmed by the X-Ray made the oblique incidence that eloquently illustrates the tilting and asymmetric rotation and also, the translation. The displacement has always been associated with these two movements. These displacements are very rarely found in Salter-Harris II fractures with medial or lateral fragment. Most of the Salter-Harris type II fractures have no displacements or a minimal displacement. In these cases, a minimal reduction followed by immobilization in a brachi-palmar plaster cast is the treatment of choice.

The displaced fragment is easily reduced; the metaphyseal fragment and the intact periosteum prevent hypercorrection. Usually, a well-applied, molded plaster is enough.The presence of the mentioned displacements and the lack of a medial or lateral metaphyseal fragment has referred the doctor to a supracondylar fracture.

In an emergency, at the first consultation any doctor in such a context can consider a supracondylar fracture with a trajectory through the olecranon fossa. The radiological, frontal and profile image does not allow the

establishment of details for the diagnosis of such a type of fracture.

The Salter-Harris type II fracture has been known since 1898, after the classification of Poland, under several names, depending on the receptivity and preferences of the authors and especially, on the existing trends in certain periods. Thus, the transphyseal fracture type II is the same fracture Poland type 2, Bergenfeldt 2 and 3, Aitken 1 and Brashear 1.

The classification system used to assess fractures, according to the involvement of the physis, metaphysis and epiphysis is important because it has implications for both prognosis and treatment [9-11]. The fractures included in the Salter-Haris classification are anatomically systematized, easier to memorize and remeber and encompasses the most common forms, that every licensed pediatric faces with. This classification has become the most widely used and is significant for therapeutic conduct.

Salter-Harris II fractures, although they represent 75% of transphyseal fractures, the number of cases in the humeral palette is small. Their frequency is 1% (5 out of 510)[12].

The anatomical and structural features of the humeral palette mean that the other types of fractures do not respect the total percentage value.

Type I fractures represent 1.4% (2 aut of 147), type III fractures 6.3% (8 out of 126), type IV fractures 1% (1 out of 104) and type V fractures are in first plac those of type V are on the first plac, 33.9 % (2 out of 62) [12].

All these data make any doctor be restrained in establishing or even suspecting a Salter-Harris II fracture with posterior metaphyseal fragment, even if the oblique radiograph of the elbow illustrates a small posterior spur, which seems to be a posterior metaphyseal segment represented by the olecranon fossa. Tilting and asymmetric rotation of the distal fragment have made this dorsal spur to be difficult to interpret. Its dimensions appeared much smaller and they were confusing, with a slightly higher fracture, than the others.

Although the trajectory of the fracture was oblique, it could not be ascertained with certainty that the fracture affected the physis.

All these data, some definite, others difficult to identify radiologically, were rather oriented towards a supracondylar humerus fracture, Gartland type 3, unstable and possibly irreducible by the interposition of soft tissues. The surgery was certain.

The open approach of the fracture revealed a fracture, which affected the physis along its entire length. The fracture had a an oblique trajectory, from posterior to anterior, of about 2 cm thick. The distal fragment had posteriorly attached a small metaphyseal fragment, a cortical lysereum with fenestrated edges and the olecranian fossa in its entirety. The proximal fragment had the two columns separated by an intercolumn incision, the afferent half of the olecranon fossa being absent. The evaluation of these details and the complete detachment of the olecranon fossa from the proximal fragment allowed the certification of the diagnosis of Salter-Harris II fracture with posterior fragment.

Tilting, translation and the asymmetric rotation of the distal fragment have determined the rupture of the periosteum and the configuration of an periosteal flap interfragmentally interposed, which made the orthopedic reduction ineffective. The impossibility of orthopedic reduction of the fracture was also given by the marginal cortico- spongy lysereum, the oblique trajectory of the fracture and the presence of the olecranon fossa attached to the distal fragment.

The repositioning of the distal fragment by closed reduction could not be done due to a) lack of synchronization of maneuvers to reduce the 3 types of displacements, b) oblique fracture, c) avulsed olecranon fossa and small metaphyseal fragment against the d) interposition of the periosteum.

The initial diagnosis of Gartland III supracondylar fracture was made only on the basis of two radiological incidences, frontal and profile.

Frontal X-Ray did not show the oblique trajectory from posterior to anterior, as a result

of the addition effect. Profile X-Ray highlighted the oblique surfaces of the fragments without being able to discern whether the fracture trajectory had dropped to the level of physis or not.This image could be plausible for a type II C Ogden fracture with posterior metaphyseal fragment.

The oblique X-Ray has showed the tilting, translation and asymetric rotation incidence, but did not eloquently reveal the sign of Holland, but only the probability of the existence of a metaphysical fragment. The small posterior lysereum was only identified intraoperatively. The presence of the Holland sign in this case is very difficult to identify, in both, lateral and oblique incidence.

The correct diagnosis of "Salter- Harris II Fracture with Gartland Modified IV Displacement and Periost Interposition" was established intraoperatively, due to the irreducibility of the fracture.

In 2006, Leitch et al. [13] presented Gartland type lV fracture as a fracture that may only be diagnosed intraoperatively. The periosteum is completely ruptured, leading to high fracture insta- bility in both flexion and extension. Multidirectional instability of type IV fractures may be caused by the injury itself or by failed attempts to reduce the fracture.

The lack of data about the SH II fracture with posterior metaphyseal fragment at the level of the humeral palette, as mentioned in the literature at the level radius and tibia femur, makes the doctor to think carefully about this type of fracture.

From the literature, physicians know that of the five most common types of Salter-Harris fractures, type II is the most common (75%) followed by types III (10%), IV (10%), type I (5%), and type V which is very rare [7]. In this case, the presence of a metaphyseal fragment was suspected and confirmed intraoperatively.

Similar cases, similar to this case, in terms of diagnosis, are also found in the case of chondral lesions of the humeral palette. Patients go to the doctor with elbow pain, limitations of elbow mobility or even total ankylosis that occurred after minimal or seemingly spontaneous trauma. In these cases, ultrasonography is useful to establish a correct diagnosis. Arthrography can also be a useful investigation. MRI complements the data provided by the other investigations and establishes details on the location of the lesion, the size of the fragment and guides the therapeutic conduct.

Sports gymnasts, children and adolescents, in especially girls who are around 11 years old, have chondral lesions such as disecans capitallum osteochondritis. The injuries are severe and the total recovery rate is 33% (3/9). Only 3 out of 9 could return to sports activity [14].

In the case studied, the metaphyseal fragment was a small lysereum along the entire posterior edge."Double X" osteosynthesis provided a good restrainment.

In type II fractures when the metaphyseal fragment is small and the fracture is unstable, the percutaneous pinning is used. If the fracture is unstable and the metaphyseal fragment is big or moderate, the fixing is done from metaphysis to metaphysis, if possible with pins.

The attempt to reduce the fracture was made under general anesthesia. It is known that most Salter-Harris type II fractures are treated by closed reduction; only type IIa with an angle of less than 20 degrees does not usually require reduction.

The practice of reduction without anesthesia should be stopped. To avoid injury to the fractured physis, it is reccomended, that the reduction to be done under anesthesia and muscle relaxation [15]. When the reduction is made early and by appropriate maneuvers the injury is prevented by scraping or compressing the free segment of the physis by the more prominent edge of the metaphysis [16-18].

Fixing in "double X" [19] allowed a good co-optation of the fragments in this low form of Salter-Harris II fracture with posterior metaphyseal fragment.

5. Conclusions

In the Salter-Haris II fracture with posterior fragment, the diagnosis was not made at the initial presentation after the clinical consultation and the frontal and profile X-rays. Some useful details for diagnosis, prognosis and treatment are established by the pediatric orthopedist at the emergency room or on the ward, possibly after further investigations.

In order to establish the surgery indication, the patient also underwent an oblique incidence X-Ray, which provided as reliable data, the tilting, asymetric rotation and translation, of the distal fragment.

The definite diagnosis in this type of Salter-Harris II fracture with posterior metaphyseal fragment and Gartland IV modified by Leitch was established intraoperatively. Clarification of the preoperative diagnosis can be done by CT and CT- 3D or MRI.

The surgery had a definite indication and the "double X" osteosynthesis has provided safety and rapid recovery.

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References

1. Challa S, Agarwal-Harding KJ, Levy P, Barr-Walker J, Sabatini CS: Supracondylar humerus fractures in low- and lower middle-income countries: a scoping review of the current epidemiology, treatment modalities, and outcomes. Int Orthop. 2020; 44(11): 2443-8.
2. Mlinde E, Amlani LM, May CJ, Banza LN, Chokotho L, and Agarwal-Harding KJ: Outcomes of Nonoperatively Treated Pediatric Supracondylar Humeral Fractures at the Nkhotakota District Hospital, Malawi. JBJS Open Access 2021; 6(3): e2100011. doi: 10.2106/JBJS.OA.21.00011
3.Salter RB, Harris WR: "Injuries Involving the Epiphyseal Plate". *J Bone Joint Surg Am 1963;* 45 (3): 587–622. doi:10.2106/00004623-196345030-00019. Archived from the original on, 2013.
4. Cope R: Radiologic history exhibit. Charles Thurstan Holland,1863-1941. Radiographics : a review publication of the Radiological Society of North America; 15 (2): 481-8. doi:10.1148/radiographics.15.2.7761652.
5.Burnei G:“ Double X” Cross Fixationin Paediatric Supracondylar Humerus Fractures: A 20-Year Expertise and 94 Surgical Interventions. Annals of Clinical and Medical Case Reports 2020; 5(6): 1-12.
6. Holland CT: A radiographic note of injuries to the distal epiphysis of the radius and ulna. Proc R Soc Med 1929; 22: 695- 700.
7. Levine RH, Foris LA, Nezwek TA, et al: Salter Harris Fractures. In: StatPearls. Treasure Island (FL): Update 2021, Stat Pearls Publishing
8. Peterson HA, Madhok R, Benson JT, Ilstrup DM, Melton LJ: (1994) Physeal fractures: Part 1, Epidemiology in Olmsted County, Minnesota, 1979-1988. J Pediatr Orthop 1994; 41:423-30.
9. Gibreel W, Charafeddine A, Carlsen BT, Moran SL, Bakri (2018) Salter -Harris Fractures of The Distal Fhalanx: Treatment Algorithm and Surgical Outcomes. Plast Reconstr Surg 2018; 142(3): 720-9.
10. Binkley A, Mehlman CT, Freeh E. Salter-Harris ll Ankle Fractures in Children: Does Fracture Pattern Mater? J Orthop Trauma 2019; 33(5) e190-5.
11. Burnei G et al: The therapeutic attitude in distal radial Salter and Harris type I and II fractures in children. J Med Life 2010; 3(1): 70–5.
12. Peterson HA: Physeal fractures: Part 3, Classification. J Pediatr Orthop 1994; 14:439-448.
13. Leitch KK, Kay RM, Femino JD, Tolo VT, Storer SK, Skaggs DL: Treatment of multidirectionally unstable supracondylar humeral fractures in children. A modified Gartland Type IV fracture. J Bone Joint Surg Am 2006; 88: 980-5.
14. Wilson PL, Wyatt CW, Searls WC, Carpenter CM, Zynda AJ, Vite L, Elis HB: Elbow Overhuse Injuries in Pediatric Female Gymnastic Athetles. Comparative Findings and Outcomes in Radial Head Stress Fractures and Capitellar Osteochondritis Dissecans. The Journal of Bone and Joint Surgery 2021; 103(18); 1675-84
15. Letts RM: Compression injuries of the growth plate. In: Uhthoff HK, Wiley JJ (eds). Behavior of the Growth Plate. Raven Press 1988, New York, pp 111-8.
16. D’Angelo F, Solarino G, Tanas D, Zani A, Cherubino P, Moretti B: Outcome of distal tibia physeal fractures: a review of cases as related To risk factors. Injury 2017; 48(3): 7-12
17. Arnold A, Thigpen CA, Beatie PF, Kissenberth MJ and Shanley E (2017) Overuse Physeal Injuries in Youth Athetles. Sports Health 2017; 9(2):139-47.
18. Ho-Fung VM, Zapala MA, Lee EY: Musculoskeletal Traumatic Injuries in Children: Characteristic Imaging Findings and Mimickers. Radiol Clin North Am 2017; 55(4); 785- 802.
19. Burnei G, Răducan ID, Enache F, Dărăban AM, Avram CR, Burnei C: Double X” Fixation for Rare and Particular Pediatric Supracondylar

Humerus Fracture. Medical Research Archives 2021; 9(6):

