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BILATEROTRICIPITAL APPROACH TO THE ELBOW

*Its Application in the Osteosynthesis of Supracondylar Fractures of the
Humerus in Children**

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In the treatment of supracondylar fractures of the humerus in children we consider the reduction as "correct" if: lateral displacement is under a third of the width of the diaphysis, without losing contact between the surfaces of the fracture in the sagittal plane; the rotation is slight; and the angle deviation is not greater than 10° from the frontal view, and 20° from the lateral view. Accepting more significant dislocations would mean a challenge to the remodelling process of growth that, in most cases, will provide deficient results. When a satisfactory reduction through conservative methods is not successful, we do not hesitate to apply surgical treatment. This treatment, properly carried out, provides good anatomical and functional results. Osteosynthesis is also indicated whenever vascular damage is involved and for open fractures.

To apply surgery to the elbow, the approach more frequently used is the posterior one, since at this level there is only the ulnar nerve, easily released and protected. The obstacle presented by the triceps is overcome in different ways in the literature: Langenboeck (1864) makes an incision in the muscular fibres lengthwise; Kocher (1907) penetrates through the lateral intermuscular septum; Lexer (1919) disinserts the triceps tendon; Alglave (1921) performs osteotomy of the olecranon; while Campbell (1932) and Tavernier (1934) section transversally the venter of the muscle by a V or a Z section, respectively. We

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complete the list of approaches most frequently implemented by citing Ollier (1888) who advocated a double access, one over the medial and one over the lateral side of the elbow.

If we analyze the above approaches, we note that none of them comprise the two basic conditions that, generally speaking, must characterize the proper access procedure: first, to provide an extensive exposition (in this particular case, in order to perform a reduction frequently troublesome); second, to preserve the full anatomic regional integrity (so important at functional recuperation time). The bilaterotricipital approach which we used for the first time in 1964 conforms, at least theoretically, to these principles. The present discussion will show the extent to which practice confirms the theory.

MATERIAL AND METHODS

Operative Technique

The surgical procedure will be facilitated by operating under pneumatic tourniquet and using the equipment introduced by Hernandez Ros (1945). See Figure 1 a.

Operative technique, as we published in 1967, can be established as follows:

1. Posterior mid-line incision involving the skin, subcutaneous cellular tissue and brachial aponeurosis.
2. Subfascial dissection, right in the tricipital compartment, reaching the inter-

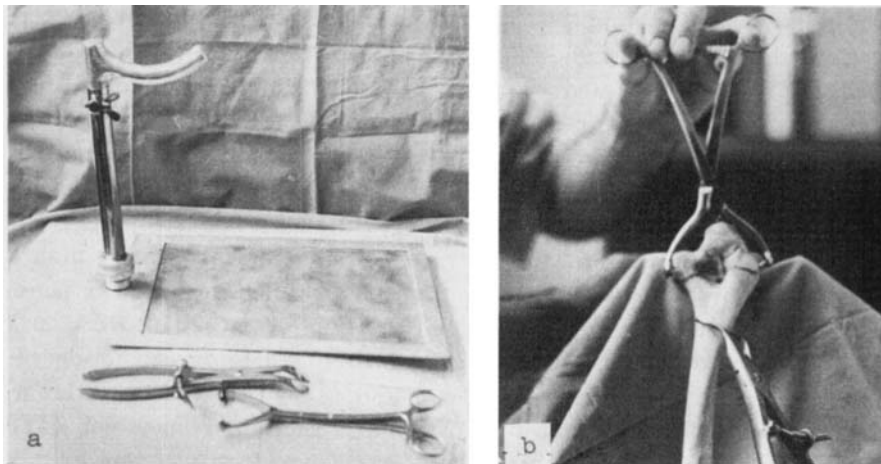


Figure 1. Instrumental introduced by Hernandez-Ros: (a) elbow support with diaphyseal and metaphyseal forceps; (b) representation of its application.

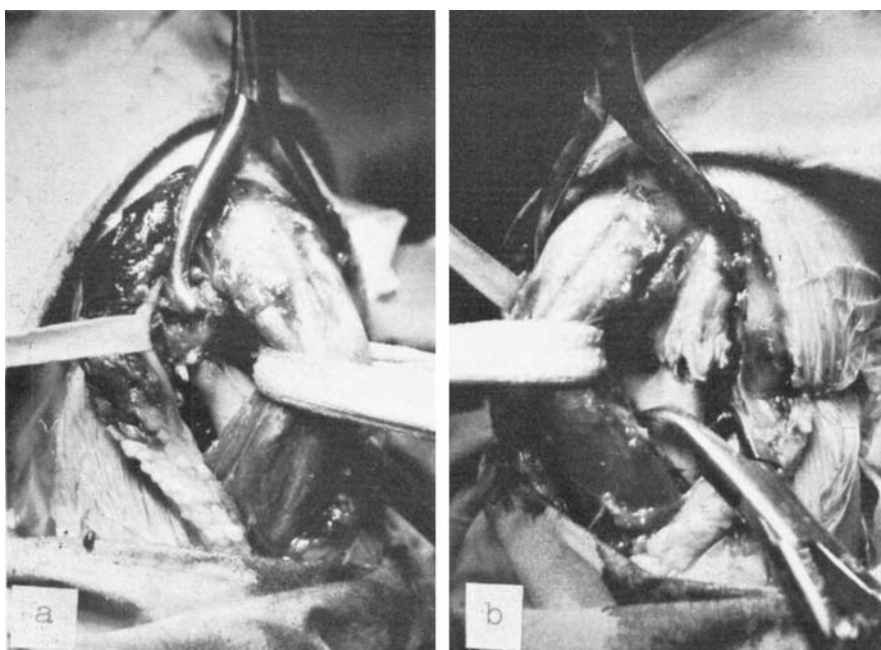


Figure 2. Operative field in the bilaterotricipital approach, with the diaphyseal and metaphyseal forceps placing: (a) cubital exposure (the line of fracture, already reduced, crosses over the fossa olecraneana and the ulnar nerve is held with a ribbon); (b) radial exposure (the line of fracture crosses the external pillar).

muscular septa. The cutaneous lips are kept averted knotting a suture stitch on the front face of the elbow. The ulnar nerve is easily released and protected.

3. Opening of inner and outer intermuscular septa by blunt dissection, enlarging the exposition with two paraolecranian incisions.
4. Passing of a gauze around the triceps (this allows for muscle displacement in both directions).
5. Cleaning of fracture focus and excision of the joint capsule that remains attached to the front face of the triceps tendon. Pillars can be released for a better control of reduction, if necessary.
6. Placing of diaphyseal and metaphyseal forceps, as Figure 1 b shows. Extension of the elbow joint in order to relax the triceps, which results in a wide exposition of fracture focus (Figures 2 a & 2 b). Reduction is achieved under visual control.
7. After fracture is reduced, the elbow joint is flexed and Kirschner wires transfix the fracture.
8. Closing of the wound is simply performed by an approximation suture.

The end of the intervention is followed by a pressure bandage to which a

posterior plaster splint is added. After ten days the skin stitches are removed and immobilization is continued with a simple dorsal plaster splint that will be removed 25 days later. Functional recuperation starts at the patient's home.

Own Cases

From October 1964 to August 1968 37 patients underwent surgery. Thirty of them were reviewed.

The age of the patients at the time of their fractures ranged from 3 to 16 years with an average of 8 years, males being affected in a 5 to 1 preference.

The main indication for the osteosynthesis was failure of closed reduction attempted under general anaesthesia, performed on 23 cases. Six patients showed intense swelling with circulatory embarrassment, facts that made us consider the manipulation as dangerous, limiting the initial treatment to the alignment of fragments applying an olecranal traction as temporary immobilization (one of these cases was operated on under emergency due to lack of radial and capillary pulse). The only case of open fracture was submitted to continuous traction and was operated on after 17 days since reduction was not achieved.

The interval time from fracture to osteosynthesis was from 3 to 8 days, except for two cases operated on during the second week.

In 23 patients bloodless field surgery lasted for 55 minutes on an average. In the 7 remaining cases bloodless field was disregarded, on some occasions due to the existence of serious doubts of vascular affection; in these cases the time of anaesthesia was from 50 minutes to 120 minutes, with an average of 80 minutes.

The operative findings have been: comminution of external pillar, in 8 cases; obliquity of fracture surfaces at inner pillar level, in 4 cases; advanced subperiosteal ossification on the patient who underwent surgery after 17 days; and very wide medullar cavity, making it difficult to obtain a steady osteosynthesis, on the older patient.

The stay in hospital was on an average 10 days; however, we must take into consideration that the average interval from fracture to osteosynthesis was 5 days.

Methods

The chief purpose of the present study is to show up to which point the bilaterotricipital approach is successful. To achieve this, nothing is better than a thorough review.

This assessment will be carried out taking into account the quality of the osteosynthesis (subordinate in part to an appropriate exposition) and the functional results (very closely connected with the muscular integrity).

In order to appreciate objectively the picture of osteosynthesis, we introduced the equation "R:rn-cn", where the first part (R) represents the quality of the reduction, being replaced by A (if the reduction is anatomic), by C (if it is correct, according to the criteria stated at the beginning), or P (when more insufficient reduction calls for poor results). The rest of the equation (rn-cn) refers to the stability of the wiring system, indicating whether needle-hooking, radial and cubital is: steady (3), when the wire goes through the opposite cortical of the proximal fragment, or runs more than 5 cm into the medullar cavity; weak (2),

if it does not conform to one of these requirements; or null (1), when the wire does not fix the proximal fragment.

For morphofunctional appraisal we have slightly modified Høyer's schema, considering "excellent" results those cases where alteration of carrying angle of the elbow is maintained between 160 and 180°, or functional deficit is not greater than 10°; "good" results, the cases where the carrying angle exceeds the previous values by 5° or when the limitation of movement does not exceed 20°; "not acceptable" results, if form or function alteration goes beyond the last figures.

In order to know the influence of the time of review, we have performed one check 4 to 18 months after the fracture, and a second one, only on those cases qualified as "good" or "not acceptable", after two years.

All these patients have been post-examined by the author, taking X-ray pictures in frontal and lateral views, clinical measurements of the carrying angle and of the range of movement, as well as photographs of the elbow laterally (flexed and extended) and from frontal view.

RESULTS

Surgical Results

Reduction

In accordance with our criteria of reduction, we qualified 21 reductions as anatomic, 7 as correct, and 2 as poor. The type of dislocation, left unreduced after treatment and responsible for not considering the reduction as anatomic, was:

1. The displacement, always less than 1/4 of the width of the diaphysis, present in 9 cases (4 cases displaced towards the radial and 5 cases towards the cubital side). In three of these cases there was associated a displacement in a posterior sense.
2. Some degree of rotation, in 2 cases.
3. The angle deviation, in varus with 10° of magnitude, in 3 cases; and in 2 cases, one of them angled also in varus, with 15° of angle deviation backwards.

Osteosynthesis

The quality of the osteosynthesis achieved in the different degrees of reduction, was:

A:r3-c3 . . . 17 cases	C:r3-c3 . . . 4 cases
A:r2-c3 . . . 2 cases	C:r3-c2 . . . 2 cases
A:r3-c2 . . . 1 case	C:r2-c2 . . . 1 case
A:r1-c3 . . . 1 case	
P:r3-c3 . . . 1 case	
P:r3-c2 . . . 1 case	

Fixation has always been steady, except for one case (with equation P:r3-c2) who endured a secondary deviation with migration of cubital wire and changing the varus angle from 10° after reduction to 15° on subsequent controls.

Clinical Results

The results of this study obtained from the first and the second examinations, are shown in Table 1.

Table 1. Relation between degree of reduction and clinical results in the first and last examination.

Reduction	Clinical results					
	first examination			re-examination		
	excellent	good	bad	excellent	good	bad
Anatomic (21 cases)	14	4	3	20	1	—
Correct (7 cases)	4	2	1	4	3	—
Poor (2 cases)	—	—	2	—	—	2
	18	6	6	24	4	2

First Check

All patients operated on were examined from 3 to 18 months after surgery.

Flexion was limited in 23 cases (average limitation was 15°), and extension in only 9 cases (with an average of 7°). Only 3 cases showed a full range of movement. The cases with functional limitation, whose average value was 15°, are grouped as follows: 19 cases with a functional limitation up to 10°, 5 cases with a functional limitation from 10 to 20°, 4 cases ranging from 20 to 30°, and 2 cases ranging from 30 to 40°.

Deformity was found in 3 patients, always in the direction of the cubitus varus. In two cases, its magnitude was 5°, and in the other 15°.

The qualification of the clinical results obtained from the first review, was: 18 cases, "excellent"; 6 cases, "good"; and 6 cases, "not acceptable".

Taking into account the cases rated as not excellent, we find:

1. From the 6 cases rated as "good": 4 cases were reviewed 3 to 7 months after surgery, and the other 2 cases were poorly reduced, with a varus of 10°.

- 2. Among the cases rated as "not acceptable": the oldest patient in the series; one case who underwent surgery 17 days after fracture; 2 cases showing poor reduction, both with angulation backwards and one of them with varus deformity; the only case with surgical infection; and one girl who did not cooperate.

Second Check

Only the cases qualified as "good" and "not acceptable" in the previous review (a total of 13 patients) have been re-examined 2 years after the fracture. In agreement with most of the authors we consider the results at this time almost definitive.

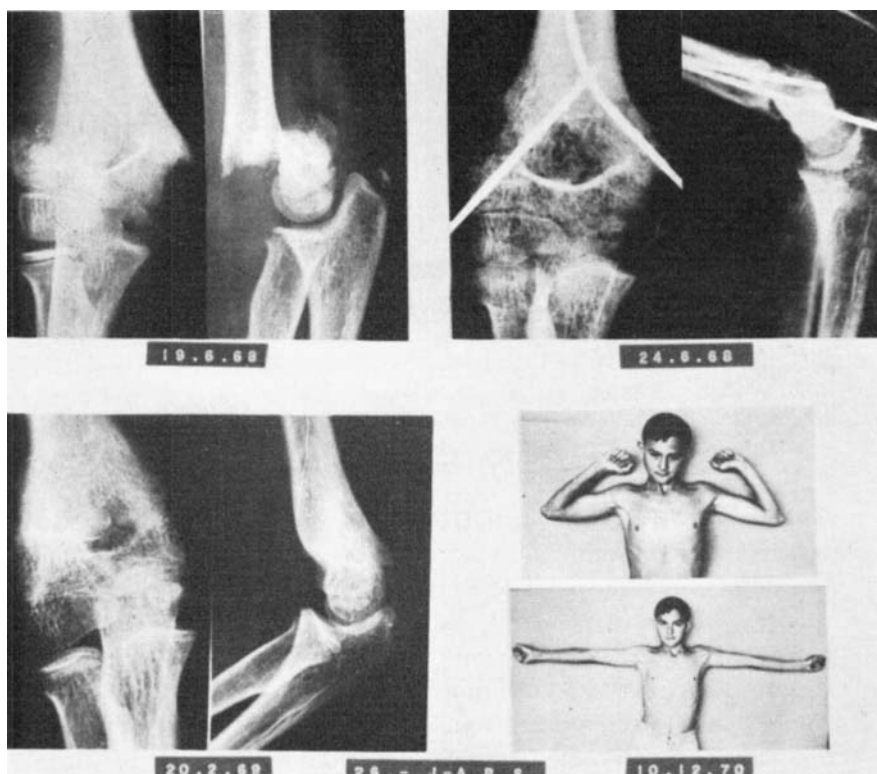


Figure 3. Case no. 25. Open reduction and osteosynthesis were carried out on 22.vi.68 with good results (equation A:r2-c3). Two weeks later the patient came back to the clinic sustaining a large infection. In the last examination (10.xii. 70) the result was qualified as "excellent".



Figure 4. Case no. 28. Treated by closed and then open reduction with osteosynthesis on 3.viii.68. The radiological picture shows an angle deviation of 10° in varus and 15° backwards, with the cubital wire placed weakly (equation P:r3-c2). In the consolidation check, we could see that the cubital wire had migrated and a secondary displacement had occurred (in the cubital sense). This patient was qualified as "not acceptable".

1. The 8 cases rated as "good" evolved differently whether they were qualified taking into account the functional limitation or the deformity. The 4 cases with a time of recuperation under 7 months in the first check improved their mobility and were classified as "excellent"; while the 2 cases with varus deformity did not show further variation.
2. The 6 cases evaluated as "not acceptable" evolved in the following way: two cases, the first one suffered infection (Figure 3) and the second one very slow recuperation, were qualified as "excellent"; two cases, one operated on 17 days after the fracture and the other one corresponding to the oldest case of the series, were qualified as "good"; and two cases, both reduced unsatisfactorily

(Figure 4 shows case no. 28), still have the qualification of "not acceptable".

We can state the end results as follows: 24 cases, "excellent", 4 cases, "good" and 2 cases, "not acceptable".

It must be noted that, except for the only surgical infection case, no other type of complications has been observed (Volkman's retraction, myositis ossificans, osteochondritis, growth plate alterations, etc.).

DISCUSSION

Among other factors, the difficulty in achieving a "correct" reduction is determined by: (1) the small size of the distal fragment; (2) the intensity of local oedema; and (3) the special configuration of the fracture surfaces (comminution in outer pillar, obliquity in inner pillar, and between both areas the olecranon fossa, which offers a true line of fracture rather than a real surface). Very often, an obvious relationship has been found between incorrect reductions and middling results (Sidorenko 1961, Lagrange & Rigault 1962, Henriksen 1966), especially for cubitus varus deformity (Madsen 1955, Bro-Rasmussen 1958, Mann 1963, El-Sharkawi 1965).

In agreement with Tavernier & Guilleminet, Holmberg (1945) and Kolesnikov (1967), we consider it the proper behaviour to employ the open treatment whenever orthopedic reduction fails. Menegaux's opinion (1959): "the end results will be better after a mediocre orthopedic reduction than after an anatomic surgical reduction", would only be partially valid if we use too harmful approaches. Distinguishing what part belongs to surgery itself and what to approach used is a very important question. As stated by Cabitza (1960), we think that many authors do not take advantage of surgery because they fear articular rigidity. In this aspect we must remember that Campbell already felt that "the secret lies in the way of access". Decoulx et al. (1964) point out that the fibrotendinous block secondary to suture, in the cross-sections of triceps, could alter elbow mobility as the quadriceps lesions endanger the knee function.

The bilaterotricipital approach guarantees a good exposure of the fracture and a maximum safety of regional anatomy, requiring as a counterpart greater skill from the surgeon, although he always could disinsert the triceps tendon in case of serious difficulties. In the present series osteosynthesis was performed by several surgeons (21 cases by the author) and it was never necessary to disinsert the triceps, This

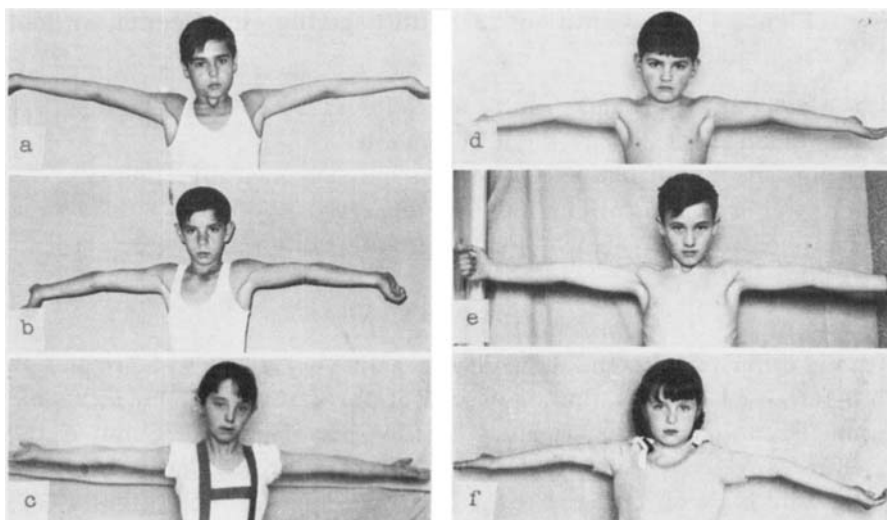


Figure 5. Some of the cases with full extension in the first examination: no. 6, A:r3-c3 (follow-up of 15 months); no. 10, A:r1-c3 (follow-up of 12 months); no. 17, A:r3-c3 (follow-up of 13 months); no. 16, A:r3-c3 (follow-up of 12 months); no. 23, A:r3-c3 (follow-up of 8 months); no. 27, A:r3-c3 (follow-up of 6 months).

eventuality will be very seldom necessary if we take into account the technical aspects that we would like to emphasize: (1) performing dissection in the tricipital compartment for better identification of intermuscular septa; (2) completing the exposition with paraolecranean incisions, extirpation of joint capsular remains attaching to the triceps, and releasing of pillars; and (3) relaxing the triceps through elbow extension when performing reduction.

When analysing results which have not reached the excellent qualification, we encounter the oldest patient in the series and the case whose intervention was carried out after the longest period. So we can consider both circumstances as factors delaying functional recuperation considerably. In the 4 remaining cases, deformity has been in 3 of them the component predominating the clinical picture, always coinciding with a non-anatomic reduction. As far as secondary deviation risk is concerned, it is strongly considerable if a poor reduction is associated with a weak fixation (as case no. 28, -equation: P:r3-c2-).

One detail worth mentioning is the slowness in flexion recuperation, perhaps associated with anterior brachial muscle lesion (Matti 1934). However, extension has been rapidly recuperated (Figure 5) contrary

to limitations existing when triceps is injured. This full extension was also obtained in the case with surgical infection.

The great importance of the time factor in evaluating results is obvious in the different qualifications in each of the revisions performed.

The change introduced in Høyer schema (1952) is based on the personal opinion that deformity must be evaluated from unsightly and absolute limits (160–180°), disregarding individual variations.

S U M M A R Y

Thirty supracondylar fractures of the humerus in children aged between 3 and 16 were treated with open reduction and osteosynthesis from a bilaterotricipital approach. In this series it was never necessary to sever the triceps to get a good exposure.

The quality of the reduction, the steadiness of the osteosynthesis and the clinical results (24 "excellent", 4 "good" and 2 "poor") may be considered as satisfactory, although the operation was performed on very serious fractures in which the conservative treatment was unsuccessful.

Among the six cases not rated as "excellent", four could be related with a non-anatomic reduction (always angulation), one with the late application of surgery (17 days after fracture) and the other with the age of the patient (the oldest one).

It is worthwhile to stress the rapidity in obtaining the full extension, and this fact is connected with the possibility of getting an appropriate reduction of the fracture without injuring the extension apparatus. It seems evident that the limitation of the extension is in connexion with the triceps lesion. Nevertheless, the alteration of the morphology (deformity) depends on the quality of the reduction.

A C K N O W L E D G E M E N T S

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R E F E R E N C E S

- Alonso-Llames, M. (1967) Nueva vía de acceso posterior al codo. *Rev. Ortop. Traum. (Madr.)* IX-IB, 11.
Baumann, E. (1965) *Ellbogen*, p. 13. Georg Thieme Verlag, Stuttgart.

- Bro-Rasmussen, F., Iversen, H. J. & Kurz, L. (1958) Treatment of supracondylar fractures of the humerus in children. *Acta chir. scand.* **116**, 134-143.
- Cabitza, A. (1960) L'intervento tardivo di riduzione e la contenzione post-operatoria nelle fratture sovracondiloidee dell'omero nell'infanzia. *Minerva ortop.* **11**, 526-530.
- Decoulx, P., Decloux, M., Hepeel, J. & Decoulx, J. (1965) Les fractures de l'extremite inferieure de l'humerus chez l'adulte. *Rev. Chir. orthop.* **50**, 263.
- El-Sharkawi, A. H. & Abdel Fattah, H. (1965) Treatment of displaced supracondylar fractures of the humerus in children in full extension and supination. *J. Bone Jt Surg.* **47-B**, 273.
- Henrikson, B. (1966) Supracondylar fracture of the humerus in children. A late review of end-results with special reference to the cause of deformity, disability and complications. *Acta chir. scand.*, Suppl. 369.
- Hernandez-Ros Codorniu, A. (1945) *El codo. Sus fracturas y luxaciones*. Ediciones "Cirugia del Aparato Locomotor", Madrid.
- Holmberg, L. (1945) Fractures in the distal end of the humerus in children. *Acta chir. scand.* Vol. XCII, Suppl. 103.
- Høyer, A. (1952) Treatment of supracondylar fractures of the humerus by skeletal traction in an abduction-splint. *J. Bone Jt Surg.* **34-A**, 623-637.
- Kolesnikov, Yu P. (1967) Operative management of fractures of the distal end of the humerus in children. *Orthop. Travm. Protez.* **4**, 20.
- Lagrange, J. & Rigault, P. (1962) Fractures supracondyliennes. *Rev. Chir. orthop.* **48-4**, 337-414.
- Madsen, E. (1955) Supracondylar fractures of the humerus in children. *J. Bone Jt Surg.* **37-B**, 241.
- Mann, T. S. (1963) Prognosis in supracondylar fractures. *J. Bone Jt Surg.* **45-B**, 516.
- Matti, H. (1934) *Fracturas y su tratamiento*. Ed. Labor, Madrid.
- Menegaux, J.-C. (1959) Fractures de l'extrémité inférieure de l'humérus. *Encyclopédie médico-chirurgicale. Appareil locomoteur*, p. 9. Editions Techniques, Paris.
- Ollier, L. (1888) *Traite des resections et des operations conservatrices qu'on peut practiquer sur le systeme osseux*. Lyon.
- Sidorenko, A. S. (1961) The effect of displacement upon the form and function of the elbow joint in children supracondylar fracture. *Ortop. Travm. Protez.* **8**, 17-20.

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