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Contribution of Ulna Radialization in the Treatment of Radial Bone Loss: Two Cases Treated in Niger

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Abstract **Case Report**

The reconstruction of bone losses in the forearm is a real therapeutic challenge in routine practice. When all chances of limb reconstruction seem exhausted, amputation is often proposed. The technique of bone reconstruction in the forearm by radialization of the ulna, also called ulnarization of the radius described by Hey Groves, is a better rescue alternative. We report the results of ulna radialization in two patients treated in Niger, in a context of high prevalence of bone complications of sickle cell disease. This technique is a good alternative to amputation, with acceptable functional results allowing the patient to integrate socio-professionally activities.

Keywords: Bone-Loss, Forearm, Reconstruction, Ulna Radialisation, Niger.

INTRODUCTION

Bone loss in the antebrachial region, regardless of its etiology, is a major therapeutic problem to solve. In fact, multiple procedures have been proposed for reconstructing the two bones of the forearm: shortening and osteosynthesis in the case of small loss of substance, reconstruction by cortico-cancellous grafting when the tissue environment is favorable, and vascularized fibula grafting in the case of extensive loss of substance [1].

However, when all chances of restoring pronosupination have been exhausted in cases of extensive radial bone loss, and amputation appears to be the only solution, a salvage alternative is to propose forearm reconstruction by radialization of the ulna, also known as ulnarization of the radius. This is the "one-bone forearm" technique, first described by Hey Groves in 1921[2-4].

Despite the high prevalence of septic pseudarthrosis with loss of bone substance at the antebrachial level, linked to the high prevalence of sickle cell disease in Niger [5], this technique of repair by radialization of the ulna has been little described.

The aim of this study was to report the results of the management of two cases of radial bone loss treated by radialization of the radius in a specialized department in Niger.

OBSERVATIONS

CASE 1

This was an AM patient, aged 07, schoolgirl, right-handed, seen in consultation at the department for a painful deformity of her left forearm and wrist. The pain was permanent, measuring 8/10 on the visual Analog Scale (VAS), and accentuated by any attempt at mobilization. She had already undergone two operations for left radial pandiaphysitis three years previously.

Clinical examination revealed scars from an old approach to the left forearm **(Fig. 1a)**. The limb was shortened by approximately 4 cm compared with the contralateral limb.

There was also a radial boot-hand deformity of the left wrist, with dorsal keloid scarring **(Fig. 1a)**. There was significant wrist stiffness with absence of supination **(Table I)**. Elbow joint movements were normal. There were no vasculo-nervous disorders.

Table I: Preoperative joint amplitudes

	Poignet droit	Poignet gauche
Flexion	80°	45°
Extension	50°	40°
Inclinaison radiale	15°	40°
Inclinaison ulnaire	40°	10°
Pronation	80°	30°
Supination	85°	0°

Imaging revealed a diaphyseal bone loss of more than 2/3 of the radius, filled with acrylic cement. There was also a protrusion of the ulna medial to the carpus. The infectious work-up was normal.

An indication for radialization of the ulna was established and performed in two stages. In the first stage, the old anterolateral approach was reused, and intraoperative bone and soft tissue samples were taken for bacteriological examination and stabilization by axial and distal radio-ulnar pinning, combined with a new acrylic cement spacer. A complementary brachio-plamar splint was fitted. Postoperative management was straightforward.

Four months later, the patient underwent radialization of the left ulna via a double approach: one using the previous anterolateral approach, the other posteromedial and arciform. After removal of the pins and cement, the edges of the distal radial fragment, which was friable, were dressed. An osteotomy was then performed on the distal quarter of the ulna, to allow transposition of the proximal ulna through the interosseous membrane and secure it to the distal end of the radius. The ulnar head was retained.

The ulna was embedded in the radial metaphysis and stabilization was achieved using steel wire cerclage supplemented by a 6-hole radio-ulnar third tube plate, with the left forearm in neutral position.

The radiological check-up was satisfactory. Passive rehabilitation of the fingers and wrist was started at 03 weeks post-op, and active at 6 weeks. At the last postoperative follow-up of 02 years, there was good scarring, and the thoracic limb was shortened by 04 cm compared with the contralateral limb **(Fig. 1c)**. She was pain-free. Radiographically, there was good fusion between the ulna and radius, creating a single bone **(Fig. 1b)**.

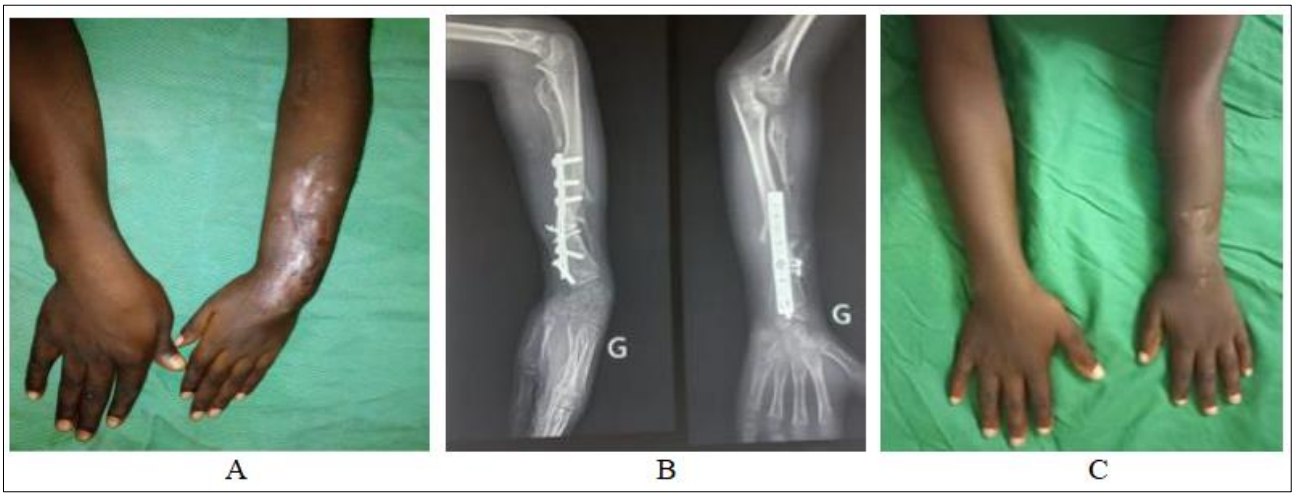

Figure 1: management sequence with radialization of the left ulna in the first case.

a) Local preoperative appearance with a radial boot-hand deformity on the left.

b) Radiographs of left forearm from the front and in profile at two years post-op, showing good fusion between the radius and ulna.

c) Local condition at last review. Good skin healing and absence of deformity.

CASE 2

This was the case of a young OA, aged 08, seen in consultation for a painful and disabling deformity of the left forearm. The patient was a sickle cell trait AS carrier with a history of chronic osteomyelitis of the left radius, surgically treated by sequestrectomy two years previously. Pain was intermittent and rated 7/10 on the VAS, accentuated by any attempt to mobilize the left forearm and wrist. The limb was almost unusable, and the child had stopped his school activities.

On clinical examination, we noted a longitudinal surgical scar on the posterior aspect of the left forearm. The limb was shortened by 05 cm compared with the contralateral limb, and pronosupination was virtually impossible. In the wrist, there was a "radial boot hand" deformity, with a protrusion of the ulnar head and a callus opposite the ulnar head (Fig. 2a). There were no local signs of infection, and elbow mobility was normal. Joint amplitudes of both wrists are summarized in the table below.

Table II: Preoperative range of motion of both wrists

	Poignet droit	Poignet gauche
Flexion	80°	70°
Extension	50°	50°
Inclinaison radiale	15°	10°
Inclinaison ulnaire	40°	30°
Pronation	80°	0°
Supination	85°	0°

Sensitivity and active motor skills in the fingers and elbow were preserved. The radius was almost non-existent on the radiographic images. The ulna was radialized in a single operation.

We used the old posterior forearm incision and tunneled the interosseous membrane at wrist level. The edges of the distal radial fragment were avivated. The ulnar head was resected, and the proximal ulnar fragment was transposed through the tunnel and set in the distal radial fragment (Fig. 2b). Restraint was achieved with a cross-bracket and Blount staple. The wrist was pronated ten degrees. The skin callus was resected, and skin closure was achieved using a suction redon drain. A brachio-antébrachio-plamar posture splint for one week, then replaced by a removable wrist splint for up to 6 weeks, completed the surgery.

Post-operative follow-up was straightforward. Passive rehabilitation of the fingers, depending on pain, was started immediately post-op, followed by active rehabilitation of the wrist after 6 weeks.

At the last follow-up we noted:

- Satisfactory local condition despite limb shortening (figure 2c).
- Functionally: the patient was able to use his hand in daily activities despite limited wrist extension and flexion.

Radiographically, consolidation was achieved at 06 months post-op.

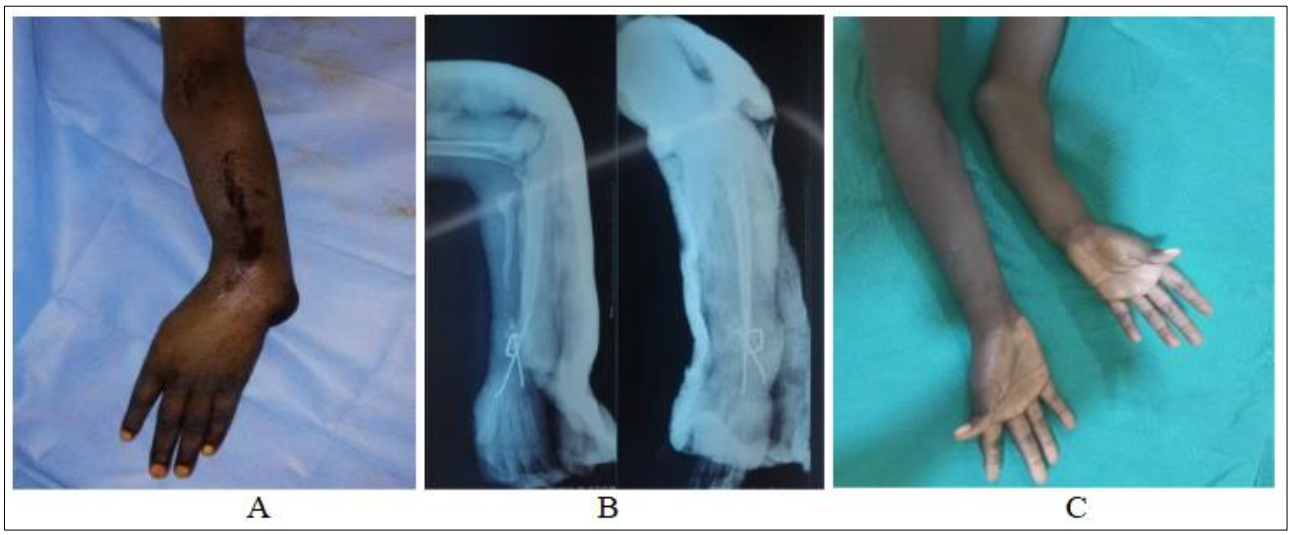

Figure 2: Management sequence with radialization of the left ulna in the second case.

a) Preoperative local condition with radial boot hand deformity
b) Immediate post-operative control radiograph with pinning and stapling.
c) Local condition at last review with good healing of the local condition.

DISCUSSION

According to Peterson CA *et al*., in the Mayo Clinic series of 19 patients, the diversity of indications for ulnar radialization gives rise to two classes of patients: reconstructions in the context of trauma or infection, and reconstructions in the context of congenital or tumoral problems [6].

According to several authors in Africa, Europe, America, and Asia, diaphyseal sequestrectomy in children, performed before the formation of an involucrum, is strongly discouraged, as it can result in a large loss of bone substance responsible for pseudarthrosis, which is very difficult to manage [7-12]. Rasool specifies that when this sequestrectomy involves the radius, the result is: shortening of the radius, while the ulna becomes outgrown and angulated; limitation or abolition of pronosupination; and a "radial boot hand" deformity of the wrist. This deformity results in reduced finger-grip strength, wrist pain and cosmetic damage. When, despite extensive bone loss, an intact radial epiphysis remains, he recommends a "single-bone forearm" with radialization of the ulna [8]. In this study, we report two cases of postosteomyelitis radial pseudarthrosis in children with extensive bone loss, but with intact proximal and distal metaphysis and epiphysis.

The posterior approach is the most used [4-13]. In our study, we used a double approach combining an anterolateral and a posteromedial approach to radialize

the ulna. For the second case, we used a single posterior arciform approach to the wrist, with extension to the forearm. The choice of approach was motivated by the desire to minimize aesthetic damage and soft-tissue distress by using the same approach as that used for sequestrectomy and cementoplasty.

From a technical point of view, radialization of the ulna consists in preserving the proximal end of the ulna as an elbow and the distal end of the radius as a wrist, at the cost of pronosupination. This radio-ulnar synthesis can be performed proximally, medially, or distally, depending on the site of bone loss [1].

Haddad also proposes a variant in which a distal radio-ulnar synostosis is performed, irrespective of the affected bone [14]. In the case of ulnar loss of substance, this proposal results in the persistence of pronosupination on the radial head, but risks humero-radial instability [15].

In our study, a distal radio-ulnar synthesis was performed, due to the large loss of bone substance at the diaphyseal level, with the persistence of a radial epiphysis. In the first case, we used the modified Greenwood technique, preserving the ulnar head. In the second case, we resected the ulnar head, as it was responsible for an unsightly skin callus.

Sahdi *et al*., in 2018 in Malaysia [11], and Radovan *et al*., in Serbia in 2013 [16], all used the Greenwood technique in nine-year-old patients. Meziani and Izhar-Ul-Haque [4-7], respectively used the original Hey Groves technique. About forearm positioning, most authors recommend a neutral or slightly pronated position of 10 to 45 degrees [6-17].

Bessy *et al*., in France [1], Izhar-Ul-Haque in Zambia [7], and Rasool in South Africa [8], placed the forearm in the neutral position in their respective studies. Sahdi *et al*., in Malaysia in 2018 [11], and Iqbal in 2022 in the USA [12], adopted a slight pronation of 10 degrees.

In our series, we positioned the forearm in the neutral position for the first patient, and in 10 degrees of pronation for the second. In the second case, the deformity was so severe that a neutral position could not be achieved intraoperatively. Pronosupination was abolished in both patients, with no major repercussions on activities of daily living.

In their series, Bessy *et al*., recommend stable osteosynthesis combined with cancellous grafting [1]. According to Meziani, Clippinger *et al*., osteosynthesis can involve direct screw fixation on two juxtaposed bones using the stair-step technique, a plate or nail inserted through the olecranon, pinning or cerclage [4-18]. In our study, we achieved stable osteosynthesis with cerclage and screw-plate osteosynthesis in one case, and relatively stable fixation with a Blount staple in the second. In both our cases, after embedding the ulna in the radius with good consolidation.

Postoperative complications vary in the literature. Some authors have noted postoperative complications such as disassembly of the osteosynthesis and exposure of the material, necessitating revision surgery [6]. In their studies, Benameur and Kim also noted a lack of skin coverage and persistent pain after radialization of the ulna [19, 20]. Meena described a postoperative infection [21]. However, no complications were detected in our study.

Other authors have obtained results like ours, including Bessy, Izhar-Ul-Haque and Sahdi [1-11]. However, as Rasool points out, it is very important to ensure regular follow-up of these patients until the end of bone growth, as it can be a source of long-term complications [22].

The integrity of the elbow and wrist joints seems to be a matter of course for the quality of the functional result, and improves the areas of mobility of the thoracic limb. The best results are obtained when the proximal end of the ulna and the distal end of the radius are preserved [23].

In both our patients, pronosupination is abolished, but is compensated for by shoulder movements. Both patients have resumed their school activities, and are using their thoracic limb to a greater or lesser extent, although it is shorter than the contralateral limb. They are pain-free and the aesthetic results are satisfactory. Several authors have reported satisfactory functional and aesthetic results after ulnar radialization in their respective series [1-24].

CONCLUSION

Reconstruction of large bone losses in the antebrachial frame is usually synonymous with recovery of the essential forearm function of pronosupination. When this cannot be achieved, the single-bone forearm seems to be the most reasonable proposal.

Fixed in a slightly pronated or neutral position, radialization of the ulna enables the forearm to regain acceptable function and aesthetic appearance, and could well avoid a series of repeat surgeries with disappointing results. It is a technique that can easily be performed in countries with limited technical resources.

Conflict of Interest: The authors declare no conflict of interest related to this work.

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