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Management of Aseptic Non-Unions of the Humeral Shaft: A Retrospective Study of 40 Cases

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Abstract **Original Research Article**

The surgical management of humeral shaft non-union remains a challenge for the orthopaedic surgeon. The aim of this work was to analyse the epidemiological, clinical, radiological and therapeutic features of aseptic non-union of the humeral shaft and to compare the outcomes of the different surgical methods used. We conducted a single-centre retrospective study of 40 cases of aseptic humeral shaft non-union treated surgically in the Department of Trauma and Orthopaedic Surgery of Mohammed VI University Hospital, Marrakech, over a ten-year period (January 2010 to December 2020). Patients aged 15 years or over with an aseptic non-union following a fracture of the humeral shaft were included; metaphyso-epiphyseal non-unions, septic non-unions, pathological fractures and incomplete records were excluded. Radiological and functional outcomes were assessed according to the criteria of Chaix and Ray and to the Stewart and Hundley classification. Forty non-unions were identified among 420 humeral shaft fractures, giving a rate of 9.5%. There was a marked male predominance (75%, sex ratio 3), the mean age was 42 years and road traffic accidents accounted for 47.5% of cases. The fracture involved the middle third in 62.5% of cases and the fracture line was simple in 80%. Atrophic non-union was the most frequent pattern (47.5%). All patients were operated on through an antero-lateral approach with systematic identification and protection of the radial nerve; treatment combined debridement of the non-union site with internal fixation and stimulation of osteogenesis by autologous bone grafting and/or osteomuscular decortication. Bone union was achieved after the first procedure in 38 patients (95%), within a mean of five months. Functional results were excellent in 18 cases, good in 19 and fair in 3. Compression plating combined with bone grafting remains the reference treatment; bone grafting is mandatory in atrophic forms.

Keywords: Humeral shaft, non-union, aseptic, compression plating, bone graft, osteomuscular decortication, radial nerve, functional outcome.

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INTRODUCTION

The humerus ranks third among diaphyseal fractures after the tibia and the femur and accounts for 5 to 10% of adult fractures seen in emergency trauma units. These fractures are frequent in young male adults and usually follow high-energy trauma, the typical example being the road traffic accident.

As with any diaphyseal fracture, humeral shaft fractures carry a risk of non-union estimated at 8 to 13% [1, 2]. Established diaphyseal non-union is defined by the arrest of the healing process, generally six to nine months after the initial trauma. It is a particularly disabling condition, responsible for pain and functional impairment, and represents a major therapeutic challenge for the orthopaedic surgeon.

The principles of surgical treatment remain unchanged: debridement of the non-union site, stimulation of osteogenesis and rigid fixation [3]. The aim of the present study was to describe the epidemiological characteristics of our series and to assess the long-term functional and radiological results of surgical treatment.

MATERIALS AND METHODS

This was a single-centre retrospective study of 40 cases of aseptic non-union of the humeral shaft treated surgically in the Department of Trauma and Orthopaedic Surgery of Mohammed VI University Hospital, Marrakech, between January 2010 and December 2020. Patients aged 15 years or over presenting with an aseptic non-union following a fracture of the humeral shaft were

included. Metaphyso-epiphyseal non-unions, septic non-unions, non-unions occurring on pathological fractures and incomplete medical records were excluded.

Data were collected from hospital admission registers and from clinical records, and included demographic data, the mechanism of injury, the initial treatment, the anatomical and radiological pattern of the non-union, the surgical technique used and the post-operative course. Radiological and functional results were assessed according to the criteria of D. Chaix and A. Ray and to the Stewart and Hundley classification [4]. All patients gave their informed consent and the study was conducted in accordance with the ethical standards of the institution.

RESULTS

1. Epidemiological data

Among the 420 humeral shaft fractures recorded during the study period, 40 progressed to aseptic non-union, giving a rate of 9.5%. There was a marked male predominance with 30 men (75%) and 10 women (25%), i.e. a sex ratio of 3. The mean age was 42 years, with a peak between 30 and 45 years. Road traffic accidents were the leading cause (47.5%), followed by occupational accidents (25%) and falls (22.5%).

The fracture involved the middle third in 62.5% of cases, the proximal third in 22.5% and the distal third in 15%. The fracture line was simple in 80% of cases. Ten fractures (25%) were open. Initial treatment had consisted of compression plating in 15 cases, intramedullary nailing in 10 cases, external fixation in 4 cases, a hanging cast in 7 cases and traditional bone-setting (jbira) in 4 cases. The time to established non-union ranged from 7 to 12 months.

2. Clinical and radiological findings

Pain was the main symptom, reported by all patients with a mean visual analogue scale score of 7/10. Complete functional impairment of the limb was present in every case. Clinical and radiological analysis allowed the non-unions to be classified as atrophic in 19 cases (47.5%), eutrophic in 12 cases (30%) and hypertrophic in 9 cases (22.5%) (Figure 1).

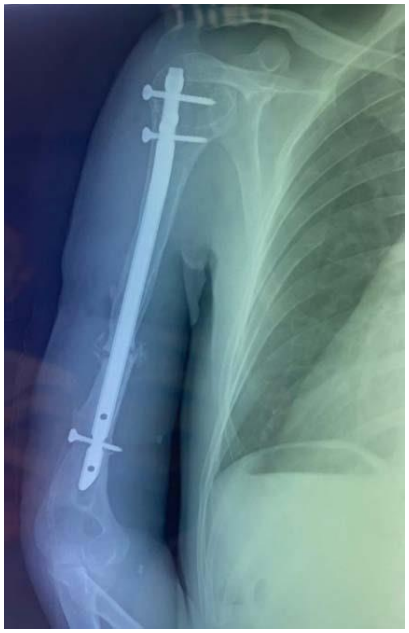


Fig. 1a: Atrophic mid-diaphyseal non-union initially treated by intramedullary nailing



Fig. 1b: Hypertrophic non-union with varus angulation and hardware failure

3. Surgical management

All patients were operated on under general anaesthesia through an antero-lateral approach. After identification and protection of the radial nerve — a key operative step (Figure 2) — treatment consisted of debridement and freshening of the non-union site followed by internal fixation combined with stimulation of osteogenesis (Figure 3): compression plating with cortico-cancellous grafting and osteomuscular decortication in 25 cases (62.5%), compression plating with cortico-cancellous grafting alone in 5 cases (12.5%), compression plating with decortication alone in 6 cases (15%), and intramedullary nailing with cortico-cancellous grafting in 4 cases (10%). Rehabilitation was started during the first post-operative week in all patients.

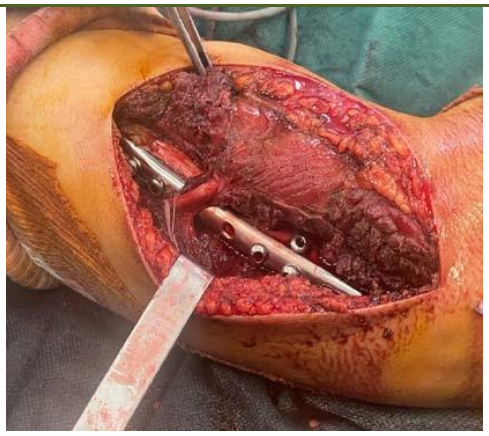


Fig. 2a: Intra-operative identification of the radial nerve

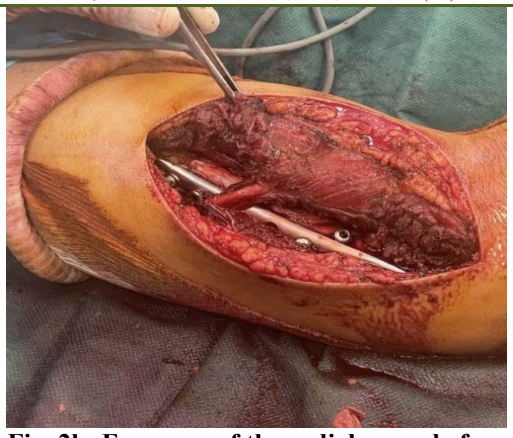


Fig. 2b: Exposure of the radial nerve before internal fixation



Fig. 3a: Osteomuscular decortication according to the Judet and Patel technique

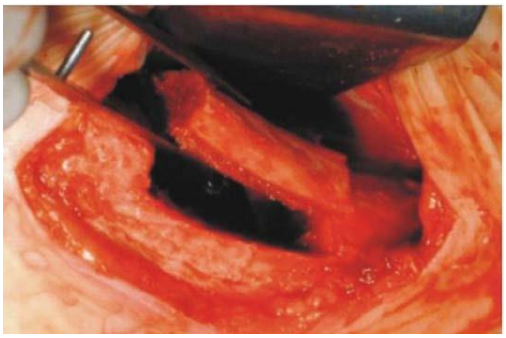


Fig. 3b: Harvesting of the autologous graft from the iliac crest

4. Therapeutic results

Thirty-eight patients achieved bone union after the first procedure (95%), within a mean of 5 months (range 3 to 7 months) (Figures 4 and 5). The two failures — atrophic non-unions treated by decortication alone without bone grafting — were successfully revised by repeat compression plating combined with cortico-cancellous grafting.

Eutrophic and hypertrophic non-unions healed more readily (100%, within 3 to 4 months) than atrophic ones (89%, within 5 months). According to the Stewart and Hundley classification, functional results were excellent in 18 cases, good in 19 and fair in 3. Three transient post-operative radial nerve palsies were observed (7.5%), all of which resolved spontaneously. No post-operative infection was recorded.



Fig. 4a: Initial radiograph of an atrophic non-union of the distal third (AP view)



Fig. 4b: Same case, lateral view



Fig. 4c: Final construct: DCP plate with bone graft



Fig. 5a: Satisfactory radiological union at 7 months of follow-up

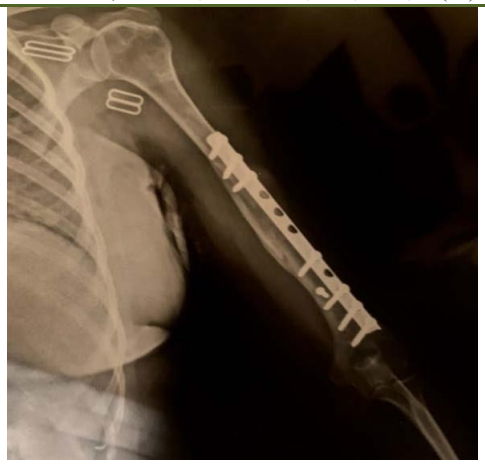


Fig. 5b: Satisfactory radiological outcome at 18 months of follow-up

DISCUSSION

Our work concerns 40 cases of aseptic non-union of the humeral shaft collected over a ten-year period. The rate of 9.5% is consistent with the figures of 4 to 13% reported in the literature [1, 2]. The epidemiological profile is that of a young male patient (75%), with a mean age of 42 years, injured in a road traffic accident in 47.5% of cases. This male predominance is also reported by Segonds and Alnot, who found 76.6% of men in their series [3].

Involvement of the middle third (62.5%) was the most frequent location, which is in keeping with the literature (60 to 70%) [1, 3]. This may be explained by disruption of the main nutrient artery of the humeral shaft, which enters the bone at the distal part of the middle third. Atrophic non-union was the most frequent pattern in our series (47.5%) and is also the most difficult to treat, as it mandatorily requires a bone graft — a finding confirmed by our two failures, both of which had been treated without grafting.

The combination of compression plating and bone grafting remains the reference technique [5, 6]. Our union rate of 94.4% for cases treated by plating is comparable to the 90 to 100% reported in the literature [5, 6, 7] (Table I).

Table I: Comparison of the results of treatment by compression plating

Authors	No. of cases	Union rate (%)	Mean time (months)	Sepsis	Radial nerve palsy
Galliard and Masquelet [5]	15	98	6	1	1 transient
Sami and Sahnoun [6]	58	98	6	1	2 transient
Segonds et al. [3]	30	99.1	6.7	–	–
Lin et al. [7]	86	97	4.5	2	5 transient
Dahmani [8]	20	100	6.8	–	2 transient
Our series	**36**	**94.4**	**5**	**0**	**2 transient**

Intramedullary nailing combined with bone grafting (100% union in our 4 cases) remains a valid alternative for hypertrophic non-unions of the proximal third. Several authors, however, report higher failure and revision rates after locked intramedullary nailing of humeral non-unions, mainly because of insufficient rotational stability and of the limited biological stimulation provided by the technique [9, 10]. Bone transport by the Ilizarov method has also been described, but it is generally reserved for septic non-unions and for segmental bone defects [11] (Table II).

Table II: Results of published series of locked intramedullary nailing

Authors	No. of cases	Union rate (%)	Mean time (months)
Galliard and Masquelet [5]	3	98	4
Sami and Sahnoun [6]	6	93	5
Loomer and Kokan	6	97	6
Dahmani et al. [8]	20	94	5.8
Our series	**4**	**100**	**5**

Neurological complications, dominated by radial nerve palsy (7.5% in our series), were all transient. No infection was recorded. Functional results, with 92.5% of excellent and good outcomes, are comparable

to those reported in the literature (Table III). Early rehabilitation, started during the first post-operative week, is a determining factor of the final functional result.

Table III: Functional results according to the Stewart and Hundley classification

Authors	No. of cases	Excellent	Good	Fair
Sami and Sahnoun [6]	58	20	25	13
Galliard and Masquelet [5]	15	7	5	3
Raissouni and Kasmoui [12]	15	8	6	1
Dahmani [8]	20	13	5	2
Amadou Ba [13]	21	12	7	2
Our series	**40**	**18**	**19**	**3**

The main limitations of this work are its retrospective and single-centre design, the absence of a control group and the heterogeneity of the initial treatments, which make direct comparison between the surgical techniques difficult.

CONCLUSION

Aseptic non-union of the humeral shaft typically affects young, active male patients injured in road traffic accidents. Its occurrence is most often related to initial treatment that was insufficient or inappropriate.

Our study confirms that compression plating combined with bone grafting and/or osteomuscular decortication is the reference treatment, with a union rate of 95% and satisfactory functional results comparable to international data. Bone grafting is essential, particularly in atrophic forms.

The best treatment nevertheless remains prevention: appropriate and technically rigorous management of acute fractures, control of modifiable risk factors and prolonged rehabilitation.

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REFERENCES

1. Healy, W. L., & White, G. M. (1987). Non-union of the humeral shaft. Clinical Orthopaedics and Related Research, 219, 206–213.
2. Rosen, H. (1990). The treatment of non-unions and pseudarthroses of the humeral shaft. Orthopedic Clinics of North America, 21(4), 725–742.
3. Segonds, J. M., & Alnot, J. Y. (2003). Pseudarthroses et retards de consolidation aseptiques de la diaphyse humérale. Revue de Chirurgie Orthopédique et Réparatrice de l'Appareil Moteur, 89(2), 107–114.
4. Stewart, M. J., & Hundley, J. M. (1955). Fractures of the humerus: A comparative study in methods of treatment. The Journal of Bone and Joint Surgery (American Volume), 37(4), 681–692.
5. Galliard, J., & Masquelet, A. C. (2005). Pseudarthroses de l'humérus : technique chirurgicale et résultats. Revue de Chirurgie Orthopédique et Réparatrice de l'Appareil Moteur, 91(2), 115–122.
6. Sami, H., & Sahnoun, M. (2004). Traitement des pseudarthroses de la diaphyse humérale par plaque vissée et greffe osseuse (58 cas). Annales Orthopédiques de l'Ouest.
7. Lin, J., Hou, S. M., & Hang, Y. S. (2000). Treatment of humeral shaft non-unions with humeral locked nails. The Journal of Trauma, 48(4), 695–703.
8. Dahmani, O. (2008). Les pseudarthroses de la diaphyse humérale [Thèse de doctorat en médecine]. Faculté de Médecine et de Pharmacie, Marrakech, Maroc.
9. McKee, M. D., & Miranda, M. A. (1996). Management of humeral non-union after the failure of locking intramedullary nails. Journal of Orthopaedic Trauma, 10(7), 492–499.
10. Dujardin, F. H., & Mazirt, N. (2000). Échec de l'enclouage centromédullaire verrouillé des pseudarthroses de la diaphyse humérale. Revue de Chirurgie Orthopédique et Réparatrice de l'Appareil Moteur, 86(8), 773–780.
11. Kocaoglu, M., Eralp, L., & Tomak, Y. (2001). Treatment of humeral shaft non-unions by the Ilizarov method. International Orthopaedics, 25(6).
12. Raissouni, Z., & Kasmoui, H. (2007). Place de l'ostéosynthèse par plaque vissée dans le traitement de la pseudarthrose aseptique de la diaphyse humérale (15 cas). Revue Marocaine de Chirurgie Orthopédique et Traumatologique, 30, 27–31.
13. Amadou Ba. (2006). Pseudarthroses diaphysaires humérales : étude de 21 cas. Annales Orthopédiques de l'Ouest.