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Pseudarthrosis of the scaphoid: what place for conservative treatment using extracorporeal shock wave therapy?

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Abstract

Pseudarthrosis of the scaphoid is a relatively frequent complication (5-10%), the pathophysiology of which is linked in particular to poor vascularization, especially of the proximal pole. The optimal treatment for pseudarthrosis of the scaphoid has not yet been established and remains controversial. Among the non-surgical options, extracorporeal shock wave therapy (ESWT) has proved to be a reliable and effective non-invasive modality for patients with delayed or non-healing fractures. We report a retrospective study conducted in the Department of Physical and Rehabilitation Medicine at CHU Ibn Rochd, including 8 patients with scaphoid pseudarthrosis. Conservative radial shock wave therapy (ESWT) was performed over 4 sessions at 1-week intervals (3000 pulses per session, mean energy flux density 0.6 mJ/mm2). Clinical and radiological assessment was performed before treatment and two months after its completion. A significant improvement in algo-functional scores and complete consolidation of the pseudarthrosis site was achieved in 87.5% of patients. Extracorporeal shockwave therapy appears to be a reliable and effective non-invasive modality for the treatment of scaphoid pseudarthrosis.

Keywords: Pseudarthrosis; Scaphoid; ESWT; QuickDash

1. Introduction

Scaphoid fracture is the most common carpal bone fracture. It mainly affects young people. Due to its particular location and vascularization, it can develop into pseudarthrosis in 5 to 10% of cases, leading to early osteoarthritis of the wrist, which can be very debilitating for the patient [1,2].

The optimal treatment for scaphoid pseudarthrosis has not yet been established and remains controversial. Among the non-surgical options, extracorporeal shock wave therapy (ESWT) has proven to be a reliable and effective non-invasive modality for patients with delayed or non-healing fractures. [4-6].

Extracorporeal shockwave therapy is a therapeutic modality originally introduced into the clinic under the name of lithotripsy, which has also been used successfully over the last two decades in the non-invasive treatment of delayed or non-healing fractures. It interacts at several cellular and molecular levels, inducing regeneration rather than repair [7,8,9].

2. Materials and methods

We conducted a retrospective study between January 2023 and December 2024 in the Department of Physical and Rehabilitation Medicine at CHU Ibn Rochd, including 8 patients with pseudarthrosis of the scaphoid. Conservative radial

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shock wave therapy (ESWT) was performed over 4 sessions 1 week apart (3000 pulses per session, mean energy flux density 0.6 mJ/mm2, adjusted according to the patient's pain tolerance).

A clinical and radiological assessment was carried out before treatment and two months after its completion. This included a clinical examination and pain assessment using a visual analogue scale. Functional outcome was assessed subjectively using the QuickDash outcome measure and the Mayo Wrist Score. An initial radiographic evaluation (Figure 1) was performed (Schnek 1 incidence), showing the location of the pseudarthrosis according to Schernberg's radiological classification (Figure 2). A follow-up radiograph was taken 2 months after the end of treatment to assess consolidation.

Figure 1 Pseudarthrosis of the right scaphoid localised at the proximal pole 1 year after the initial trauma (Iconography from the physical medicine and rehabilitation department at CHU Ibn Rochd)

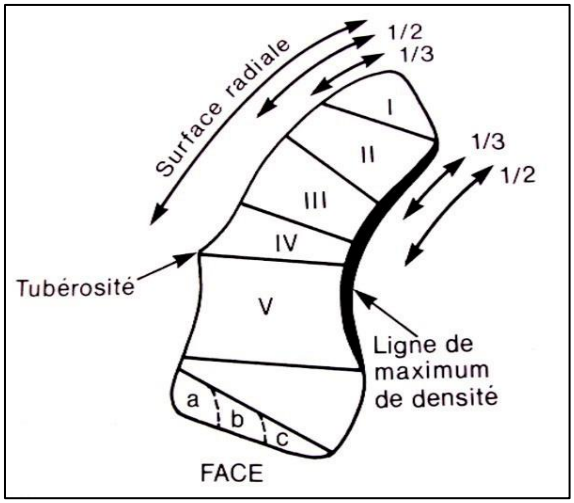

Figure 2 Schernberg distinguished six fracture types (I–VI) ranging from the proximal pole to the distal tubercle using the lateral tuberosity and the radial and medial articular surfaces as references. Distal tubercle fractures were further divided into small (a), intermediate (b), or large (c) fragments, and were considered likely to heal successfully, contrary to proximal fractures [21]

3. Results

The sample consisted of 8 men with an average age of 26.8 years. Six patients had heavy manual work. The dominant hand was affected in 62.5% of cases. 87.5% of patients were active smokers at the time of treatment. The history of trauma was present in all cases. Initial orthopaedic treatment was administered after diagnosis of the fracture, with varying degrees and duration of immobilisation. Fractures were classified according to the Schernberg classification (Figure 3) as follows: 4 in zone III, 3 in zone IV and 1 in zone V. The mean time from initial trauma to treatment was 14.8 months [SD 7.9]. Mean rest pain was 4.3/10 at baseline, with significant improvement after the end of treatment ($p>0.05$). The mean QuickDASH score was 13.8 at baseline compared with 27.3 in 2 months.

The Mayo Wrist score showed a significant improvement (initial mean score 62% vs 79%). No side effects were reported by our patients. Complete consolidation of the pseudarthrosis site was achieved in seven patients (87.5%). 1 patient had persistent pseudarthrosis, but follow-up radiographs showed a reduction in diastasis.

4. Discussion

Pseudarthrosis of the scaphoid is a relatively frequent complication (5-10%), the pathophysiology of which is linked in particular to poor vascularisation, especially of the proximal pole, but also to the absence of a periosteal envelope on the scaphoid, 80% of the surface of which is articular and therefore cartilaginous [2]. Examination of the wrist will reveal the diagnosis, based on external wrist pain and loss of mobility and strength. It may go unnoticed and only be discovered unexpectedly during a second trauma [3]. Radiological analysis of good-quality plain films of the wrist is often sufficient to distinguish a pseudarthrosis from a recent fracture. Pseudarthrosis is usually characterized by the presence of a clear fracture image, geodic bone resorption of the edges and/or osteocondensation of the edges. A CT scan provides a better understanding of the local anatomical features (bone resorption, extent of diastasis, existence of lunate tilt) and may therefore be useful if there is any doubt about the age of the fracture, whereas the viability of the proximal fragment is best explored using MRI [10,11].

The characteristics of the population were comparable to other series in the literature. The sample was composed entirely of men, of young average age (26.8 years), the majority of whom were manual workers. An identified trauma was found in all our patients, which corroborates the results of the literature [12,13,14].

Several studies have compared the efficacy of shock wave treatment with surgical treatment. Notarnicola et al. included in their retrospective study mainly conservatively treated scaphoid fractures that did not show radiological healing after 6 months. These non-union scaphoid fractures were either treated with ESWT (n=58) or surgically revised (n=60). Shock wave group parameters were selected using 4000 pulses from an electromagnetic source at a mean energy flux density of 0.09 mJ/mm2. For the primary target parameter of bone healing at 12 months, the authors again found comparable results in the two intervention groups (bone healing in 79% of the ESWT group and 78% of the surgical group). The Mayo wrist score as a clinical parameter showed excellent and good results in 57% and 60% respectively (ESWT vs. Surgery). The consolidation rate in our series was 87.5%, comparable to the success rate found by Notarnicola et al, Fallnhauser et al (71%) and Alkhawashki et al (75% for all sites combined). [12,13,14].

Cacchio et al. conducted a prospective, randomized, controlled, multicenter study to examine the effects of shock wave treatment on unhealed long bones compared with surgery. Radiological assessment, which was the primary outcome parameter, was performed at several different points up to 24 months after treatment. Radiological results showed no significant difference between the study groups, and bone healing was evident in 94% of group 1 (0.4 mJ/mm 2), 92% of group 2 (0.7 mJ/mm 2) and 95% of the surgical group after 2 years. However, the Visual Analogue Scale (VAS), the Lower Limb Function Scale (LLFS) and the Disability of Arms, Shoulders and Hands Questionnaire (DASH) showed a significantly better outcome in the ESWT groups at 3 and 6 months compared with surgery. In addition, no adverse events were observed in the ESWT groups, with the exception of small petechial haemorrhages and minor hematomas in 23 patients [15].

Systemic risk factors for bone healing were considered by Everding et al. Interestingly, although they have been shown to be negative predictors in other studies, they were unable to demonstrate a negative association between smoking and ESWT treatment success [17].

In response to increased integrin expression, focal adhesion kinase (FAK) is significantly activated by elevated phosphorylation, leading to increased adhesion, distribution and migration of osteoblasts, ultimately promoting fracture healing. Furthermore, a decreased RANKL/OPG ratio was found in shock wave-stimulated osteoblasts,

indicating inhibition of osteoclastogenesis. Increased RUNX-2 protein levels and reduced RANKL/OPG ratios promote bone healing [18].

The application of low-energy radial shock waves provides a biological revascularizing effect, rather than a mechanical rupture effect. This effect is induced by the local release of osteogenic factors such as NO, TGF-beta 1 and bone morphogenic protein 2 (BMP-2), as well as neo-angiogenic factor, a vascular endothelial growth factor. Previous research has shown that shock waves induce hyperpolarization of the cell membrane, stimulating osteoblast proliferation and promoting NO synthesis. The production of TGF-b1 and BMP-2 is thought to promote osteogenic differentiation of mesenchymal stem cells [18-20].

5. Conclusion

Pseudarthrosis is a fairly frequent complication of scaphoid fractures, due to its particular location and vascularization, which makes it difficult to consolidate. Surgical and non-surgical techniques are used to treat this complication. Among the non-surgical options, extracorporeal shock wave therapy has proved to be a reliable and effective non-invasive modality. The results obtained are comparable to those of surgery, with a clearly positive cost-benefit ratio.

However, further prospective and randomized studies are needed to substantiate these results and obtain further optimization of therapeutic parameters and subsequent treatment.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest.

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Statement of Informed consent

Informed consent was obtained from all participants included in the study.

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