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Review

Shock wave therapy of fracture nonunion

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ABSTRACT

We have used the principles of extracorporeal shock wave therapy (ESWT) in the treatment of nonunion of fractures in 44 patients (49 bones).There were 35 males and 9 females with a mean age of 34 years(range14–70). Clinical and radiological assessment was performed at regular time intervals with a minimum follow up of 18 months. Most common sites involved were the femur and tibia. The average time from initial fracture treatment to intervention with ESWT was 11.9 months (6 months to 5 years). Thirty eight non-union sites had one session of treatment and the rest (11) had more than one session. Union was successful in 75.5% of cases at a mean time of 10.2 months (range 3–19). Failure in the remaining cases was due to more than 5 mm gap, instability, *compromised* vascularity (type of bone) and deep low grade infection; which was discovered at the time of surgical intervention when no signs of radiological healing occurred after 6 months from treatment. Failing sites were shaft of femur, scaphoid, neck of humerus and neck of femur. No local complications were observed.

Contents

Introduction

A shock wave can be defined as a sonic pulse with certain physical characteristics. It has high peak pressure and short life cycle of about 10ms.It has broad frequency spectrum in the range of 16–20MHz [1].

The shock waves could be one of three types, depending on the mechanism they are produced [1,2];

- Electrohydraulic shock wave (such as the HMT OssaTron machine).
- Electromagnetic shock wave (such as the Sonocur and Dornier Epos machine).
- Piezoelectric shock wave (such as the Piezoson by Wolf).

The energy generated by these methods may be: (a) low energy <0.27 mJ/mm^2; (b) medium energy 0.27–0.59 mJ/mm^2 or (c) high energy >0.60 mJ/mm^2.

Bone responds better to high energy, whereas soft tissues *respond* better to lower energy levels. Extracorporeal shock wave therapy (ESWT) is an intense, but very short energy wave which is faster than the speed of sound (1500 m/s), translated past the skin and superficial tissues, and is focused at the desired tissue depth.

Extracorporeal generated shock waves have been introduced in routine medical practice around 1982 to treat kidney stones [3].

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Since then their application has expanded in a number of medical disciplines [2–12].

In the trauma and orthopaedic discipline, extracorporeal shock wave therapy was used successfully in the 1980s for the treatment of pseudoarthrosis [2], and more recently in other applications, such as insertion tendonitis, avascular necrosis of the head of femur and other necrotic bone conditions [3].

The results of treatment of non and delayed union with extracorporeal shock wave therapy have not been consistent, *with success rates* ranging between 50% and 85% [9,10,13–17].

The aim of this study is to evaluate the effectiveness of ESWT in a series of patients presenting to our institution with nonunion.

Patients and methods

Between January 2006 to December 2009, patients who were treated with ESWT for non or delayed union of fractures were eligible to be included in the study. Inclusion criteria included type A1 and2 nonunion, according to Weber and Cech [2] and patients who had nonunion after surgical procedures; i.e., osteotomies, as well as those previously treated, either non-operatively or by *open reduction internal fixation* (*ORIF*).

Exclusion criteria, included active infection and types A3, B1,2 and 3,and sites were open physis was *still present*.

Treatment protocol

We *used* shock wave device OssaTron (HMT High Medical Technologies AG) with movable therapy head of about 350° degree (Fig. 1).

Fig. 1. Illustrates shock wave device.

After machine preparation and fixing the limb or site of nonunion, the nonunion was marked in 2–3 areas using X-ray machine (Fig. 2).

The number of pulses depended on the site. We used 3000–4000 pulses for Femur, Tibia, Fibula, Humerus and 2000–3000 to other smaller bones. The frequency was set to 4 s^{-1} with 26 kV.

The number sessions of ESWT were as follows:

1) One session—38 bones.
2) Two sessions—9 bones.
3) Three sessions—2 bones.

Fig. 2. (a–c) Limb positioning and marking prior to initiation of ESWT treatment.