Successful treatment of sternal non-union by ultrasound

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Abstract

We report a case of sternal non-union after open aortic valve replacement surgery in a 48-year-old man. The sternotomy was repaired using stainless steel wires and later, ‘flexigrip’ cables. He presented to us six months later complaining of persistent pain in the sternotomy site. CT-scan confirmed a sternal non-union. After consultation with the ultrasound device, and aortic valve manufacturers, we established that there was no previous similar reported case, but there were no contraindications to use of ultrasound. We started treatment using non-invasive pulsed ultrasound therapy. The non-union healed clinically and radiologically within four months. This is the first report of treatment of sternal non-union using low intensity ultrasound. This therapy appears safe and can be used as a first line of treatment for adequately stabilized sternal non-unions.

Keywords: Sternal non-union; Ultrasound; Sternotomy

1. Introduction

Midline sternotomy is the commonest access route for major cardiac surgery [1]. Healing is usually good, but if problems occur, they are serious. The wound may dehisce, sometimes requiring plastic surgery, or a sternal non-union may result (incidence <1%) [2]. We report the successful treatment of a sternal non-union by non-invasive ultrasound.

2. Case report

A 47-year-old male underwent aortic valve replacement through a sternotomy approach. Postoperatively he complained of persistent sternal pain. At three months from surgery, the wound was re-explored. The sternum had not united, so the fixation of the sternum was revised, using flexigrips.

Sternal pain continued, and he was referred for an orthopaedic opinion. There was no clinical, radiological, or haematological evidence of infection. A CT-scan of the sternum at six months post valve replacement showed that the sternum remained un-united throughout its length (Fig. 1).

Correspondence with the valve manufacturer revealed that there was no theoretical objection to the use of ultrasound; but suggested increased monitoring of anti-coagulation. The manufacturer of the ultrasound device had no prior experience of its use in this clinical setting.

Low-intensity pulsed ultrasound treatment was commenced at eight months post valve replacement, using an Exogen device (Smith and Nephew) applied for 20 min per day to the upper sternum, and 20 min per day to the lower sternum.

After three months of treatment, a CT-scan of the sternum showed complete bony union of the sternum (Fig. 2). Some local discomfort from the wires persisted after union but this was much less than before. This improved after the flexgrips and sternal wires were removed at 13 months post valve surgery. By 18 months, pain had completely resolved.

3. Discussion

Sterile sternal non-union is defined as a persistent fracture of the sternum after three months without signs of healing. It is characterized by a triad of sternal instability, pain and the absence of infection [2].

The management of full dehiscence of a sternal wound is outside the scope of this paper.

The general management of any non-union involves a review of contributing reversible factors. These include smoking, and the use of non-steroidal anti-inflammatory drugs, steroids, and anti-metabolites. Clinical and radiological evidence of infection should be looked for [3], and deep tissue samples should be sent to the lab at the time of any re-operation.

If sternal non-union is associated with insecure sternal fixation, then the fixation should be revised using flexgrips or a sternal plate [2, 4]. However, if the wound has healed and the sternal fixation is secure, but there is a sympto-
matic non-union, stimulation of bone healing is required. The options are either fracture stimulation by the use of bone graft [4, 5] or bone morphogenetic protein (invasive), or the use of ultrasound (non-invasive).

Low intensity pulsed ultrasound has been successfully used for treatment of non-unions and fresh fractures at various sites. A recent meta-analysis has shown that it significantly reduces the time to fracture union [6].

Although the details of the mechanism through which low-intensity pulsed ultrasound affects cells are still unknown, in vitro and in vivo studies on animal models have revealed an increase in cell proliferation, protein synthesis, collagen synthesis, membrane permeability, integrin expression, and increased cytosolic $\text{Ca}^{2+}$ levels as well as other increased indicators of bone repair in response to low-intensity pulsed ultrasound exposure [7].

There has been no previous report of the use of low-intensity pulsed ultrasound for the treatment of sternal non-union.

This case demonstrates that a more conservative approach using ultrasound can be successful. We think that this should be tried before resorting to an extensive re-operation.

References