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Research paper

Failure analysis of the fractured wires in sternal perichronal loops

Jesús Chao^{a,*}, Roberto Voces^{b,1}, Carmen Peña^{a,2}

^a National Center for Metallurgical Research (CENIM-CSIC), Avda. Gregorio del Amo, 8, 28040 Madrid, Spain

^b Division of Cardiac Surgery, Hospital de Cruces, Plaza Cruces-Gurutzeta 12, 48902 Barakaldo, Spain

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ABSTRACT

We report failure analysis of sternal wires in two cases in which a perichronal fixation technique was used to close the sternotomy. Various characteristics of the retrieved wires were compared to those of unused wires of the same grade and same manufacturer and with surgical wire specifications. In both cases, wire fracture was un-branched and transgranular and proceeded by a high cycle fatigue process, apparently in the absence of corrosion. However, stress analysis indicates that the effective stress produced during strong coughing is lower than the yield strength. Our findings suggest that in order to reduce the risk for sternal dehiscence, the diameter of the wire used should be increased.

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1. Introduction

Median sternotomy is often used in cardiothoracic surgery, and stainless steel figure-of-eight and/or single wiring is the most common procedure for sternal closure. Recently, a new fixation technique, so-called perichronal closure (Fig. 1), has been proposed (Voces-Sánchez, 2009). The idea behind this technique is that the closure should have the sufficient rigidity to allow primary osseous healing but also sufficient flexibility for uniform distribution of the stresses to prevent wire cutting through the bone (Voces-Sánchez, 2009). Failure of postoperative sternal closure due to sternal dehiscence

is a serious issue (Bruhin et al., 2005). Dehiscence occurs, typically, within the first two weeks after surgery resulting from the fracture of suture wire or as often occurs, when it is being pulled through the bone (Brantigan et al., 1979; Wilkinson and Clarke, 1998). Comparative analysis of the dehiscence cases associated to 1188 sternotomies (669 single closures, 181 figure-of-eight closures, and 338 perichronal closures) performed from 2003 to 2008 at the institution of one of the authors (R.V) has revealed that perichronal closure allows a similar consolidation to those of single and figure-of-eight closures (Voces-Sánchez, 2009). Moreover, in practically all cases in which single or figure-of-eight loops were used, dehiscence via cutting through bone occurred whereas when

* Corresponding author. Tel.: +34 91 5538900; fax: +34 91 534 74 25.

E-mail addresses: jchao@cenim.csic.es (J. Chao), robertovoces@vodafone.es (R. Voces), c.pena@cenim.csic.es (C. Peña).

¹ Tel.: +34 94 6006339.

² Tel.: +34 91 5538900.