Eur Spine J (2006) 15: 316–320
DOI 10.1007/s00586-005-1024-1

ORIGINAL ARTICLE

Ciaran Bolger
C. Carozzo
T. Roger
Linda McEvoy
Jabir Nagaria
Gerard Vanacker
Maurice Bourlion

A preliminary study of reliability of impedance measurement to detect iatrogenic initial pedicle perforation (in the porcine model)

Received: 13 January 2005
Revised: 27 June 2005
Accepted: 12 August 2005
Published online: 13 October 2005

C. Carozzo · T. Roger
Ecole Nationale Vétérinaire de Lyon,
UP 5201, 69280 Marcy l'Etoile, France

C. Bolger · L. McEvoy (✉) · J. Nagaria
Neurosurgical Research and Development Unit, National Department for Neurosurgery, Beaumont Hospital, Dublin, Ireland
E-mail: lmcevoy1@eircom.net
Tel.: +353-1-8093929
Fax: +353-1-8092302

G. Vanacker · M. Bourlion
Spine Vision, Paris, France

Abstract Accidental perforation of the vertebral pedicle wall is a well-known complication associated with standard approach of pedicle screw insertion. Depending on detection criteria, more than 20% of screws are reported misplaced. Serious clinical consequences, from dysesthesia to paraplegia, although not common, may result from these misplaced screws. Many techniques have been described to address this issue such as somatosensory evoked potentials, electromyography, surgical navigation, etc. Each of these techniques presents advantages and drawbacks, none is simple and ergonomic. A new drilling tool was evaluated which allows for instant detection of pedicle perforation by emission of variable beeps. This new device is based on two original principles: the device is integrated in the drilling or screwing tool, the technology allows real-time detection of perforation through two independent parameters, impedance variation and evoked muscular contractions. A preliminary animal study was conducted to assess the safety and efficacy of this system based upon electrical conductivity. A total of 168 manual pedicle drillings followed by insertion of implants were performed in 11 young porcine lumbar and thoracic spines. The presence or absence of perforation detection, which defines the reliability of the device, was correlated with necropsic examination of the spines. Using this protocol the device demonstrated 100% positive predictive value, 96% negative predictive value, 100% specificity, and 97% sensitivity. Of 168 drillings there were three (1.79%) false-negatives, leading to a minor effraction, cranially in the intervertebral disks, nine (5.36%) screw threads breaching the vertebral cortex when inserting screws, although preparation of the holes did not indicate any perforation, 34 (36%) breaches detected by the instrument and not detected by the surgeon. These results confirm that the impedance variation detection capability of this device offers a simple and effective means to detect perforation in vertebral pedicle, prior to insertion of pedicle screws. Due to the porcine nerve root anatomy, it was not possible to evaluate the added benefit of cross-linking impedance and EMG detection. A future clinical study may further explore the subject of current study.

Keywords Porcine model · Pedicle screws · Radiographs · Pedicle breaches