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Review article

Headless compression screw in the neuronavigation-guided and microscope-assisted treatment of spondylolysis

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ABSTRACT

Since 1968, many surgical techniques used in repairing the pars defect of the vertebra have been reported. Technological advances are giving rise to new ways of obtaining the best outcome using less invasive methods, which are more accurate, simple and effective. To treat cases of spondylolysis such as pseudarthrosis, we used neuro-navigation and microscopy through a 2.5-cm skin incision to approach the pars defect, freshen the fracture and place a type of screw that, until now, has never been used for this purpose. This is a novel technique, which guarantees prolonged compression and sufficient stability to facilitate the prompt healing of the vertebra. We present 2 cases of L5 spondylolysis treated with our technique, a modification of Buck's technique. A detailed description of the screw selection, surgical technical details, follow-up and outcome are discussed.

Tornillo de compresión sin cabeza en el tratamiento de la espondilolisis guiada por neuronavegación y asistida por microscopio

Palabras clave:
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RESUMEN

Desde 1968 se han descrito muchas técnicas quirúrgicas utilizadas para reparar el defecto en la *pars* de la vértebra. Los avances tecnológicos están dando lugar a nuevas formas de obtener el mejor resultado utilizando métodos menos invasivos que son más precisos, simples y eficaces. Para tratar los casos de espondilolisis como una unión en seudoartrosis, se utilizó la neuronavegación y la microscopía a través de una incisión cutánea de 2,5 cm para abordar el defecto de la *pars*, refrescar la fractura y colocar un tipo de tornillo que no se ha utilizado previamente con ese fin. Esta es una técnica novedosa, que garantiza

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una compresión prolongada y suficiente estabilidad para lograr la curación oportuna de la vértebra. Presentamos 2 casos de espondilolisis de L5 tratados con nuestra técnica, una modificación de la técnica de Buck. Se realiza una descripción detallada de la selección del tornillo, detalles técnicos quirúrgicos, seguimiento y resultado.

Introduction

Spondylolysis is a fracture that occurs in the pars interarticularis of the vertebra, frequently L5, and in 25% of cases it tends to displaced.[1–3] It is currently attributed to the overload phenomenon, which occurs mostly in sports, and has been classified by different authors as: type I congenital or dysplastic; type II isthmic; type III degenerative; type IV traumatic and type V pathological.[4] Meyerding classified them radiologically according to the displacement of the L5 body over the first sacral vertebra: grade I displacement below 25%, grade II displacement between 25 and 50%, grade III displacement between 50 and 75% and grade IV displacement greater than 75%.[4] Clinically, spondylolysis is characterized by pain, attributed to nerve stimulation, and instability produced in the injured vertebral segment.[5] It is usually treated conservatively, with surgical criterion being met when the pain is disabling, hinders activities of daily living, and does not respond to drug therapy, physical therapy or orthoses.[4,6]

Many techniques have been proposed to repair the defect in the pars interarticularis. In 1968 Kimura proposed repairing the defect with bone graft, without any osteosynthetic material, and confining the patient to bed rest for a period of two months; with further use of a brace until full fusion occurs.[5–7] Scott first proposed the use of wires to provide stability to the fracture site while using autologous bone graft in 1968. He proposed cerclage, which required extensive spine dissection to allow the wire to surround the vertebra, passing in front of the transverse processes and below the spinous process of the same level.[5,7] In 1970 Buck described an internal approach to the fracture, which involved less aggressive dissection, debridement of the fracture focus, placement of a 4.5 mm cortical screw and placement of an autologous iliac crest graft.[6–10] In 1984 Morscher published a variation of the Buck technique in which the screw is incorporated with a claw which holds the lamina.[5] In 1998 Songer proposed the placement of pedicular screws in the lytic vertebra and a cerclage system similar to the Scott technique that does not require exposure of the transverse processes.[5] In 1996 Tokuhashi and Matsuzaki proposed the use of rod-hook associated pedicle screws with an iliac crest autograft at the fracture focus.[11] In 1999 Petit and Gillett described the placement of pedicle screws associated with a "U" shaped rod that passes under the spinous process at the relevant level.[5]

Few studies have biomechanically compared each of the existing techniques and their outcome. Deguchi reported better biomechanical behaviour in the screw-rod-hook technique and Buck's technique, where least movement is achieved at the site of injury.[11,12] Gadiucci compared Buck's technique with the Scott wiring technique and the Songer's modification with pedicular screw. The direct approach showed a better outcome in young patients, with Songer's technique resulting in the best outcome in the general population.[7] J. Fan reported greater stability in the screw-rod-hook and screw-rod techniques.[13] Minimally invasive variants of Buck's technique, in which the screw is placed through neuronavigation without fracture debridement have been described as an alternative for young patients,[3] including variants of the technique described for young athletes that allow direct endoscopic observation while lysis repair is done.[14,15] Traditionally, cortical screws were used in the treatment of spondylolysis in lumbar vertebrae,[3,6,7,10,11] with the use of partially threaded screws such as AO screws being reported by some authors.[4,9,15] We propose a minimally invasive and effective treatment for spondylolysis, using hardware that has never been previously considered for this purpose.

Methods

Surgical planning

To plan our surgeries we used iPlanNet® developed by Brainlab. This software allowed us to calculate the individual morphometric parameters in each case, which was necessary to find an optimal size, trajectory and location for the hardware.

Screw selection

We believe that to achieve optimal repair of the injury, it is necessary to use a trans-fracturary fixation technique with compression at the focus of the structural lesion. Therefore we decided to use the second generation of headless compression screws, HCS 4.5 (Synthes). The superiority of this screw has been clearly demonstrated when compared with the Herbert–Whipple screw and traditional cortical screws for treatment of small bone fractures and joints.[16–19] We prefer titanium to steel, not only for its hardness and strength, but also for its better biocompatibility, osseo-integration, corrosion resistance, and fewer artefacts in future MRIs. The characteristics of the tip thread and head thread as well as the length of the unthreaded shank is fully conditioned by individual patient anatomy; specifically the size of the fragments. We use the following basic principles:

1. The fracture focus must be crossed in a completely perpendicular trajectory.
2. Pre-drilling of the trajectory should be avoided to achieve a higher final compression force at the fracture focus.[20] The