IN VIVO TESTING PROTOCOL FOR DETERMINING THE PULLOUT STRENGTH OF A POLYAXIAL SCREW BY USING A CANINE MODEL

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INTRODUCTION

Bilateral longitudinal plates or rods and polyaxial screws (PAS) are used for cranio-vertebral arthrodesis (CVA) as orthopedic treatment of cervical spine disorders, and it is necessary to assure the CVA biomechanical stability because of the high degree of mobility afforded by the upper cervical spine (Puttlitz et al., 2004). In this case the mineral density of occipital bone plate and vertebral lateral masses is an important factor which contributes to that stability and therefore to clinical success, so the screw-bone interface has been evaluated by means of pullout or insertional torque tests and up-to-date fresh-frozen human cadaver bone has been used (Yamagata et al., 1992; Zdeblick et al., 1993). These kind of tests demands a lot of expensive hardware, so we propose in this work, a novel testing protocol for determining in vivo the pullout yield torque of a PAS and by this way to calculate its pullout strength. We think this protocol will be more economical and it would let us know the actual PAS pullout strength.

METHODS

At the beginning of our work we had thought to perform the PAS pullout tests as many researchers have done with pedicle screws (Yamagata, Zdeblick). A 3.5 mm-diameter and 7 mm-long polyaxial screw, used for fixing craniovertebral longitudinal plates, was fully inserted in the occipital bone plate of an anaesthetized Rottweiler young adult dog (3 years old). After this first step, we asked ourselves: “Why do we not perform the test in vivo?” Having this in mind, a pullout mechanical device (PMD) was designed (figure 1) and it will be machined in stainless steel. In the next step the PAS will be extracted for attaching the PMD to the screw head. The PAS will be inserted again and then a tightening torque will be applied with an adjustable torque wrench (ATW) and using an open end wrench as opposite wrench.

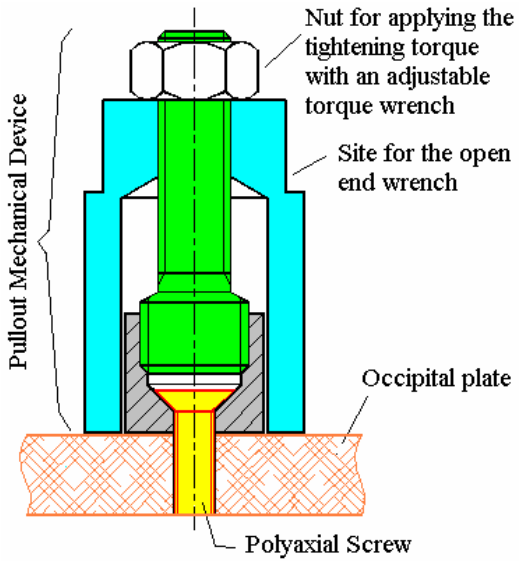

Figure 1: Cross-section of the Pullout Mechanical Device for determining the pullout strength in vivo of a polyaxial screw, by applying a tightening torque.

The tightening torque will pull out the PAS and the yield torque will be the maximum tightening torque we obtain, after which we think the torque value will decrease. The torque wrench will be adjusted in steps of 1 in-lb until the yield torque is obtained, which will be registered for calculating the pullout yield force by using the following equation (Shigley J.E. and Mischke C.R., 1990):

$$F_{poy} = T / K.d$$

Where:

F_{poy} = Pullout yield force
T = Maximum tightening torque
K = Torsion coefficient
d = Basic diameter of the nut inserted to the ATW drive socket

The first pullout test will be performed after April 2nd, at the Instituto Nacional de Neurología y Neurocirugía, México City, México.

RESULTS AND DISCUSSION

We anticipate sending you the pullout test results in April. We are sure that the PMD will accomplish our objective of evaluating in vivo the pullout strength of a PAS by using a canine model, avoiding the use of expensive hardware. This testing protocol will also save unnecessary deaths of laboratory animals.

SUMMARY

The screw-bone interface has been evaluated by means of pullout or insertional torque tests and up-to-date human cadaver bone has been used. We now propose an in vivo testing protocol to determine the pullout strength of a polyaxial screw, by using a canine model, a pullout mechanical device that we have designed, an adjustable torque wrench and an open end wrench as opposite wrench.

REFERENCES

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