

Novel Tool for the Assessment of Bone specific mechanical properties while Inserting BoneScrews

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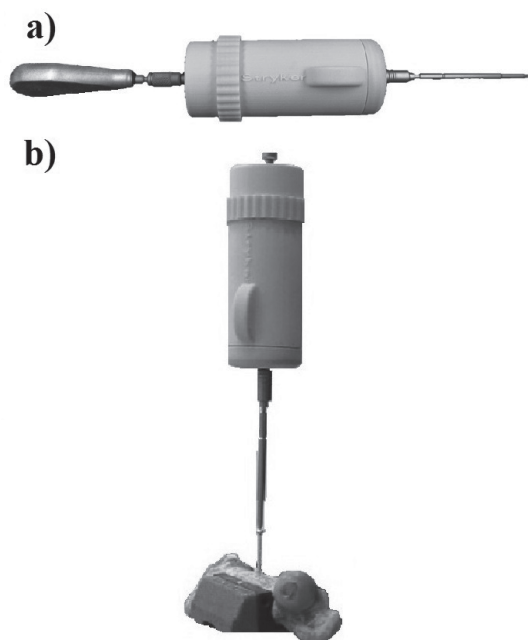
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Annually, millions of bone screws are used for treatment of bone fractures. Mostly, functionality evaluation of bone screws is done by the bone simulation materials. This delivers more consistent results than testing in real bone; however it can result in different absolute values as if performed in real bone. Thus, a novel sterilizable, portable device, in order to measure insertion torque and axial force while inserting bone screws in human bone (Cadaver Lab) is developed.

Material and Methods

The aim of this project was to develop a portable, sterilizable device that can be used for measuring the insertion torque and applied axial force of a wide range of bone screws during the screw insertion in the cadaver lab. The design is divided in three parts: screwdriver handle, measurement part and the screw driver blade. In order to protect the measurement part of the device from the contamination, a capsule made of composite is designed around this part and the data acquisition is done wireless. The calibration of first prototype and experimental test by it on the bone simulation material and animal bone are done.



a) First prototype, b) Experimental test on a porcine femur

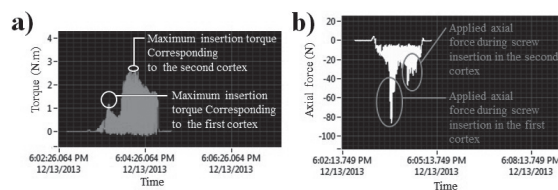
Results

The uncertainty of $\pm 0.035 \text{ N.m}$ for measuring insertion torque (measuring range $0.1\text{-}5.1 \text{ N.m}$) and $\pm 1.793 \text{ N}$ for measuring applied axial force (measuring range $1\text{-}200 \text{ N}$) for the confidence interval of 95% are achieved by the calibration procedure. All the principal requirements of the device are met. Two different sizes of ISO standard Stryker cortex bone screws are inserted by the device in a porcine femur and bone simulation material and the insertion torque and axial force are recorded and monitored real-time wireless.

Discussion

Further bone screw insertions by the device in bone simulation materials, animal bones and particularly human bones (Cadaver experiments) are needed for a sophisticated evaluation.

The assessment of the local bone quality may be performed by measuring the insertion torque. For this purpose, functionality of the real-time measuring of the bone screw insertion depth can be added to the device which would allow for a more detailed assessment of local bone quality.



Monitoring the measured a) insertion torque and b) axial force during inserting bone screw (Stryker, Standard ISO cortex, Ø4.5 50mm stainless steel screw) in a porcine femur



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