PRIMARY HIP STEM MICROMOTION ASSESSMENT: CORRELATION BETWEEN RASP AND STEM STABILITY

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INTRODUCTION

Primary stability achieved by press-fit is critical for the long-term success of cementless hip stems [1]. It is recognized that micromotions over 30-150 micron prevent osteointegration and lead to implant failure [2]. Conversely, excessive press-fit can cause intra-op fractures [3]. A device able to intra-operatively assess stem stability was developed and validated [4]. It consists of an angular sensor and a torsional load cell, which are embedded in a real-time torque wrench. The device is manually operated by the surgeon, who can use this quantitative information to decide whether more press-fit is needed.

This device could successfully discriminate between stable and unstable stems intra-operatively [4]. The goal of the present work was to find a correlation between rasp and stem stability. This could provide the surgeon with a quantitative information concerning the quality of the femoral canal just prepared before inserting the stem, thus enabling a prediction of the implant stability possibly achievable.

METHODS

The device [4] is meant to measure a stem/femur relative rotation when a torque is applied. It incorporates two high accuracy transducers, an RVDT angular sensor and a torsional load cell. A custom designed connector allows an easy and rigid insertion of the device in the stem neck modularity. As a reference point for the angular probe, a Kirschner nail is driven anteriorly on the greater trochanter prior to the insertion of the device. All the electronics is hosted in a cavity machined inside the handle. Data acquired (sampling frequency 200Hz) are recorded in a separate memory, for post-op evaluations. The surgeon interface, located in the upper side of the handle, is composed by: (i) a display, for the visualization of the stem size; (ii) four buttons to select a function of the device; (iii) two bi-colored series of LEDs, indicating the amount of torque applied and the extent of micromotion achieved.

Three composite and two embalmed re-hydrated cadaveric femurs were tested. An experienced surgeon prepared the femurs to be implanted, in a single session and following the standard surgical protocol. The tests were performed as follows: a first torque-micromotion acquisition was made with the last rasp used by the surgeon to prepare the canal still inserted into the femur. The measurement device was connected to the rasp and the angular and torsional data were acquired when a torque (up to 20Nm) was manually applied. Five to ten repetitions were performed on each femur. The same measurement protocol was repeated with the corresponding stem inserted and press-fitted in the femoral canal. Data were acquired and processed.

RESULTS AND DISCUSSION

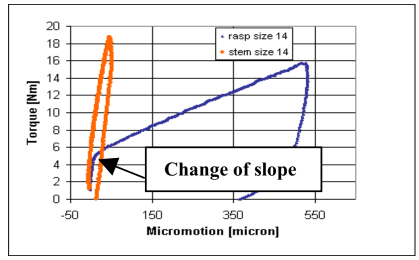

Fig.1 Typical torque-micromotion curves for the rasp and the stem on the same femur

Observing the increasing part of the torque-micromotion curve (Fig.1), the stem micromotions increase linearly, while the rasp shows a highly non-linear trend (with a pronounced "knee" corresponding to a sudden increase of the micromotion rate). Thus it was decided not to directly compare the rasp-stem motion patterns, but to search for a parameter of the rasp curve to correlate with the stem-micromotion.

The best-correlated rasp-parameter was the level of torque corresponding to the slope change in the torque-micromotion curve. This rasp parameter presented a linear trend if plotted against the stem micromotion (Fig.2), thus showing the presence of a good correlation (R^2>0.93) between rasp and stem stability.

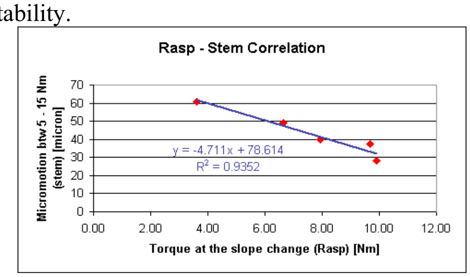

Fig.2 Correlation between rasp and stem stability

CONCLUSIONS

The aim of the present work was to investigate if it was possible to evaluate the quality of the femoral canal and predict the stem stability, by using the torque wrench, prior to the stem implantation.The correlation tests yielded satisfactory results. The rasp and stem stability seems to be strictly related.

REFERENCES

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ACKNOWLEDGEMENTS

Work financed by EC: ISAC Project IST-1999-20226.