IN VITRO AND IN VIVO ANALYSIS OF SQUEAKING FREQUENCIES IN CERAMIC-ON-CERAMIC TOTAL HIP PROSTHESIS

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ABSTRACT INTRODUCTION:
Squeaking after total hip replacement has been reported in up to 10% of patients (1). Some authors proposed that sound emissions from squeaking hips result from resonance of one or other or both of the metal parts and not the bearing surfaces (2). There is no reported in vitro study about the squeaking frequencies under lubricated regime. The goal of the study was to reproduce the squeaking in vitro under lubricated conditions, and to compare the in vitro frequencies to in vivo frequencies determined in a group of squeaking patients. The frequencies may help determining the responsible part of the noise.

METHODS:
Four patients, who underwent THR with a Ceramic-on-Ceramic THR (Trident®, Stryker®) presented a squeaking noise. The noise was recorded and analysed with acoustic software (FMaster®).

In-vitro 3 alumina ceramic (Biolox Forte Ceramtec®) 32 mm diameter (Ceramconcept®) components were tested using a PROSIM® hip friction simulator. The cup was positioned with a 75° abduction angle in order to achieve edge loading conditions. The backing and the cup liner were cut with a diamond saw, in order to avoid neck-head impingement and dislocation in case of high cup abduction angles (Figure 1). The head was articulated ± 10° at 1 Hz with a load of 2.5kN for a duration of 300 cycles. The motion was along the edge. Tests were conducted under lubricated conditions with 25% bovine serum without and with the addition of a 3rd body alumina ceramic particle (200 µm thickness and 2 mm length).

RESULTS SECTION:
Edge loading was obtained incompletely (Figure 2). In-vitro, no squeaking occurred under edge loading conditions. However, with the addition of an alumina ceramic 3rd body particle in the contact region squeaking was obtained at the beginning of the tests and stopped after ~20 seconds (dominant frequency 2.6 kHz) (Figure 3-a).

DISCUSSION:
For the first time, squeaking was reproduced in vitro under lubricated conditions. In-vitro noises followed edge loading and 3rd body particles and despite, the severe conditions, squeaking was intermittent and difficult to reproduce. However, squeaking is probably more difficult to reproduce because the cup was cut and the head was fixed in the simulator, preventing vibration to occur. Furthermore, edge loading was incompletely achieved in case of no inserted ceramic ship. No damage was observed on the components, however, the test duration was very short.

Squeaking noises of a similar frequency were recorded in-vitro and in vivo. The lower frequency of squeaking recorded in-vitro was incompletely achieved in case of no inserted ceramic ship. However, a larger cohort of squeaking patients is needed to confirm these results. The determined values of frequencies may help to analyze the squeaking patients in order to determine the mechanism generating the sound.

REFERENCES:
1- Jarret et al: The squeaking Hip: An under-reported phenomenon of ceramic-on-ceramic total hip arthroplasty. AAOS 2007, Poster 198
3- Varnum et al: Ceramic Bearings in Total Hip Arthroplasty: Frequency and Type of Noises. EFORT 9th Meeting, Nice, France 2008