Periprosthetic Bone plays a Role in the Development of noisy Ceramic-on-Ceramic Hips.

INTRODUCTION:
Rising numbers and incidence rates of noisy (squeaking, scratching or clicking) ceramic-on-ceramic (CoC) total hip arthroplasties (THA) are being reported. The etiology seems to always involve stripe wear producing a stick-slip effect in the bearing which excites vibrations. As stripe wear is also found in silent CoC bearings, a theory has been developed that the vibrations become audible only via amplification through the vibrating stem (bell-clapper theory). This was supported by showing that the excitation frequency and the resonance frequency of the plain stem are similar. However, stem resonance in-vivo would be influenced by the periprosthetic bone damping and transmitting stem vibrations. Thus, if the bell-clapper theory were true, noisy CoC hips should show periprosthetic bone different to silent hips. This study compares stem fit&fill and periprosthetic bone between noisy and silent CoC hips.

MATERIALS AND METHODS:
A consecutive series of all 186 primary CoC hips with identical stems, cups (Stryker ABG-II) and femoral heads (Alumina V40, 28mm) performed at one institution was studied. At regular follow-up a dedicated patient questionnaire investigated the presence and type of noise (squeaking, scratching, clicking or combinations), the noise frequency (quasi permanent, often, sometimes, rare), the noise level (audible by others, mainly self-audible, reproducible), the movement frequency (quasi permanent, often, sometimes, rare), the noise intensity (0-6-months, 6-24-months, >2yrs). This survey identified n=38 noisy hips (incidence rate: 20.4%) with n=23 patients reporting squeaking (12.3%). The periprosthetic bone was evaluated on the most recent post-op follow-up AP x-rays measuring stem fit&fill and cortical wall thickness (CWT, medial and lateral) according to the established method of Kim and Kim. Measurements were repeated by a single blinded observer in a control group of silent hips matched for gender, age, stem size and follow-up time (4.6yrs). Fit&fill and CWT were compared between the noisy and silent group at proximal, mid-stem and distal level and on the medial and lateral side.

RESULTS:
The endosteal canal width was equal in noisy (N) and silent hips (S) at all three levels (e.g. proximal: N=39±5.5mm, S=41.3±5.7mm, Fig. 2). On the lateral side also cortical wall thickness (CWT) was the same at all levels (e.g. proximal: N=2.0±0.8mm, S=1.9±0.9mm). However, on the medial side, noisy hips had higher CWT at proximal (N=4.9±2.8mm, S=3.0±2.1mm, p<0.01) and mid-stem level (N=6.2±2.1mm, N=4.6±1.7mm, p=0.001, Fig. 3). Also Fit&fill was slightly higher in the noisy group and mainly proximally (N=66%, S=62%) and at mid-stem: (N=63%, S=59%, p=0.05) but not at distal level. Differences and significance levels increased when in the noise group only squeakers were considered. Studying the stem position in relation to the trochanter minor, it was seen that in the noisy group a significantly higher proportion of stems was placed more proximally with relation to the lesser trochanter (LT). A comparison of the periprosthetic bone parameters at the most recent follow-up with the situation at short term follow-up (3-6months) indicated that despite the typical bone loss, the characteristic differences between the noisy and the silent groups were present already after stem implantation.

DISCUSSION:
Despite equal endosteal canal widths (indicating successful matching) and equal lateral cortical wall thickness for noisy and silent hips, noisy hips had sign. thicker medial walls at proximal (+63%) and mid-stem level (+35%) where also fit&fill was higher. Despite equal stem sizes, more noisy stems were placed further proximal relative to LT. This gives evidence that periprosthetic bone (PPB) may play a role in the development of audible noise in CoC hips by providing particular conditions of support, damping and transmission for an oscillating stem, all of which may influence noise frequency and intensity. Strong cortical walls medially plus a tight fit&fill, both at proximal level, in combination with a relatively high proximal stem position may increase the chance of CoC noise transmission for the implant system investigated. Comparing PPB at different time points indicated that the differences are less due to post-op remodeling but more to pre-op conditions or surgical canal preparation such as setting the resection level, the amount of broaching or reaming, and the stem insertion depth. While recent studies have focused on the influence of the stem material and design this study has shown that also the PPB seems to be involved in the development of noisy CoC hips. The findings are being verified by a DEXA study.

REFERENCES:
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2 Morlock M. et al. ORS 2010