DELETERIOUS EFFECTS OF ARTICULAR CARTILAGE INCLUSION IN IMPACtion BONE GRAFTING

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Introduction
A series of in vitro impaction tests were done to know the mechanical behavior of different types of morsellised grafts for impaction bone grafting. The preparation of the femoral head (the most common source) prior to milling was emphasized. This study was aimed at investigating the existing confusion about the most suitable type of graft to be used for the procedure. An estimated loss in material was tabulated to know which type of graft yielded more material to impact and which type was mechanically superior on impaction. The three mechanical parameters investigated were the height or extent of deformation of the grafts, the stiffness and the density attained on successive impactions. The grafts were impacted to very high limits (150) to know their mechanical outcome.

Materials and methods
Two batches of six femoral heads acquired from primary arthroplasties were used for this study. In each of the two batches, the femoral heads were split in two halves in the frontal plane. One half was used to produce pure cancellous morcellized grafts (by removing the cartilage and neck) in both batches. This type of graft was considered as the gold standard. The other half was used to produce cortico-cancellous with cartilage grafts (morsellizing the entire head) in batch 1 or cortico-cancellous without cartilage grafts (removing the cartilage, but not the femoral neck) in batch 2. Morsels were produced by the same mill (Noviomagnus, Spierings, Nijmegen, Netherlands). In each of the four groups, 18 five gram samples were prepared. Each of the 72 samples was separately impacted by pouring the sample in an aluminium tube (14 mm of diam.). A solid impactor was delivering a constant shock to the grafts when hit by a mass (455 g) falling over 1 meter. The procedure was interrupted regularly (at 1, 3, 5, 10, 20 and every 10 impactions in the other two without cartilage present (Figure 2). Morsels were produced by the same mill (Noviomagnus, Spierings, Nijmegen, Netherlands). In each of the four groups, 18 five gram samples were prepared. Each of the 72 samples was separately impacted by pouring the sample in an aluminium tube (14 mm of diam.). A solid impactor was delivering a constant shock to the grafts when hit by a mass (455 g) falling over 1 meter. The procedure was interrupted regularly (at 1, 3, 5, 10, 20 and every 10 impactions in the other two without cartilage present (Figure 2).

Results
Material loss on graft processing: Preparing the pure cancellous graft caused a mean weight loss of 40%. On the other hand the cortico-cancellous without cartilage and neck included spares 15% more material to impact.

Height: The pure cancellous and the cortico-cancellous without cartilage had the same extent of deformation on successive impactions, but the one with the cartilage deformed to a significantly lesser extent (p<0.05).

Stiffness: All types showed an increase in stiffness on progressive impactions. The cortico-cancellous without cartilage and pure cancellous had the same elastic modulus on impaction, but the presence of cartilage yielded a significantly lower modulus (p<0.001) on impaction. For the graft with cartilage, it took 150 impactions to attain a modulus that could be attained in 10 impactions in the other two without cartilage present (Figure 2).

Discussion
The results of the in vitro tests presented here show that the cortico-cancellous morsellised graft has the same mechanical properties as that of the widely used pure cancellous morsellised graft, and also adds 15% extra graft material to fill a cavity. Inclusion of the articular cartilage in the femoral head prior to milling adds material but prevents an efficient impaction and a resultant impacted graft layer having a lesser stiffness and density. The tests results demonstrate that it is not only the particle profile of the morsellised grafts type that influence the mechanical outcome of impaction bone grafting, but also the type of the morsellised graft used.

References
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