

# MECHANICAL TESTING OF APAPORE-60 AS A BONE GRAFT EXTENDER IN A FEMORAL MODEL

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## INTRODUCTION

Hip replacements at revision are often associated with a reduction in bone stock. To compensate a technique known as impaction allografting has been developed; morsellised graft chips are impacted into the femur (or acetabulum) prior to cementing the new implant into position<sup>1</sup>. Clinically some good short-term results have been reported<sup>2</sup>, but others have had problems of subsidence and rotation of the new stem<sup>3</sup>. The allograft is usually femoral heads harvested from primary replacements, which have been stored and tested at bone banks for at least six months, however supply is often limited<sup>4</sup>. To assist with these problems a synthetic bone graft extender, ApaPore-60, has been developed which is designed to be added to the morsellised graft in equal volumes. ApaPore-60 granules are sintered 60% porous Hydroxyapatite, that are available in two size ranges; 2-5mm and 5-10mm. It is possible that inclusion of ApaPore-60 may improve the mechanical properties of the graft. The initial mechanical properties of the graft after adding ApaPore-60 were mechanically tested in Sawbones, and compared with a control of pure allograft. **The hypothesis was that the subsidence and rotation observed during mechanical testing in Sawbones would be reduced by the inclusion of ApaPore-60 to the allograft.**

## METHODS

Twelve large femur Sawbones (Pacific Research) were used in this study, allograft was impacted in half (Group A) and a 50:50 mix of allograft and ApaPore-60 in the one half (Group M). Second generation Sawbones were chosen for their similar mechanical properties to bone. The surgical procedure was intended to mimic, as closely as possible, that of live surgery. The Exeter X-Change Revision Instruments (Stryker Homedica) were employed together with a modified slap hammer, which could record the impaction forces. The impaction technique of four surgeons had previously been established on nine patients using the modified hammer (results showed: mean Distal Impaction Force range 8.1 to 21.8kN, mean Proximal Impaction Force range 6.1 to 28.9kN).

Femoral heads, collected with patient consent, were used for the allograft. The cartilage and soft tissue was removed from the heads prior to grinding in a Noviomagus Bone Mill (Spierings Medisch Technieck). The resulting graft was washed in warm water for ten minutes to remove the fat and patted dry. To prepare the mixed graft, equal volumes of washed allograft were mixed with blood-soaked ApaPore-60 (approximately 1ml of fresh human blood was required for each 5 grams of ApaPore-60). The femoral head was cut off each sawbone and the cancellous bone was cored out to resemble a femur at revision. The graft was impacted into the sawbones using the modified hammer and the forces measured in order to test the consistency of the technique. Once impacted with graft, vacuum mixed cement was used to secure a size 1 Exeter stem into position.



Fig 1 - Measuring the prosthesis head migration with height callipers. Circular frame used to mount the LVDT's.

The mechanical test was performed in a six station hydraulic loading machine. The sawbones were mounted in the anatomical position of 7 degrees valgus and 9 degrees posteriorly. Sinusoidal loading at 2Hz was applied under the following loads: 600N, 1kN, 1.4kN, 1.8kN and 2.2kN, each loading step lasting for 5000 cycles. The load was applied to the

prosthesis head through a ball bearing plate, which allowed for horizontal travel. Vertical displacement of the prosthesis head was measured using digital height callipers at the beginning and end of each loading step (fig 1). Migration of the stem during loading was measured using LVDT. X-Rays were taken before and after mechanical testing, which were used to measure stem rotation and displacement.

## RESULTS

During impaction of the graft the average mean distal impaction force in Group A was 14.6±2.8kN, and in Group M 14.4±1.4kN. The average mean proximal impaction force of Group A was 18.1±2.9kN, and in Group M 17.0±3.6kN. Significantly more distal impacts were used during the impaction of the Allograft/ApaPore-60 mix than with Allograft alone (Mann-Whitney U Test p=0.028). However the sum of the distal impact forces and average distal impaction force did not show a significant difference between the two graft types, indicating that this did not have any real effect.

There was, however, a significant difference between the groups in the overall displacement of the prosthesis head, measured with the height calipers, (Fig 2, Mann-Whitney U Test p=0.01). Total average head movement: Group A 3.5±0.7mm, Group M 1.8±0.7mm. The total average subsidence measured with the LVDT's was 0.30mm in Group A and 0.12mm in Group M. Migration measurements of the tip of the stem from the x-rays were also small: Group A 0.58±0.49mm, Group M 0.33±0.41mm. Only one case in each group showed subsidence of the distal plug, both measured 1mm off x-rays. A sideways displacement of the prosthesis head was observed on the lateral x-rays, which has a direct relationship to head rotation, and showed significantly less rotation in the Group M (Mann-Whitney U Test p=0.003).

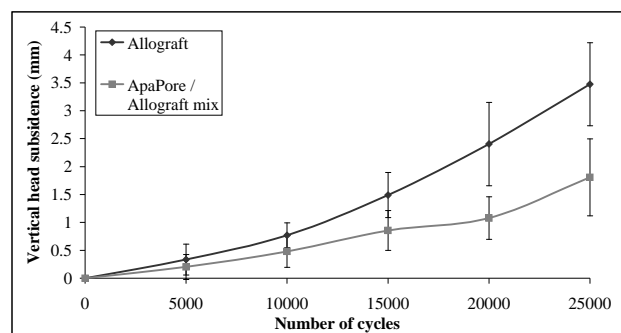


Fig 2 - Average vertical migration of the prosthesis head

## DISCUSSION

The results demonstrated that the inclusion of ApaPore-60 reduced subsidence and rotation of the stem. The modified slap hammer was able to show consistency of the impaction technique and that this was within the current surgical range. The migration of the prosthesis head was larger than the subsidence measured by the LVDT's and off the x-rays. This was because rotation of the stem, in all planes, was adding to the vertical movement of the head. The low movement of the distal plug may have contributed to lack of axial displacement in this model.

This study indicates that a 50% addition of ApaPore-60 to allograft, will offer better initial stability than allograft alone during femoral impaction grafting. However further research needs to be undertaken to investigate the long-term effects of using ApaPore-60.

## Acknowledgements

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## References

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