Objective MRI-based quantification of cartilage regeneration after stem cell therapy using segmentation-driven 3D analysis

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Background

- Current cartilage repair assessments suffer from subjective interpretation, despite MRI being the gold standard imaging technique.
- Aimed to analyze cartilage volume and thickness changes through objective image segmentation methodology following Stanmore Stem Cell Therapy(SSCT).

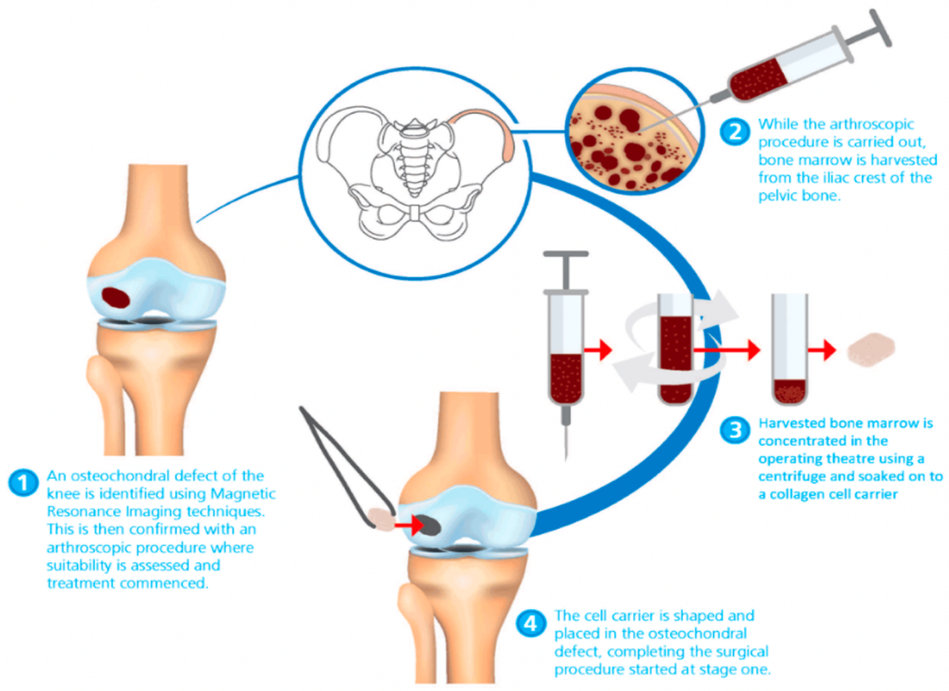


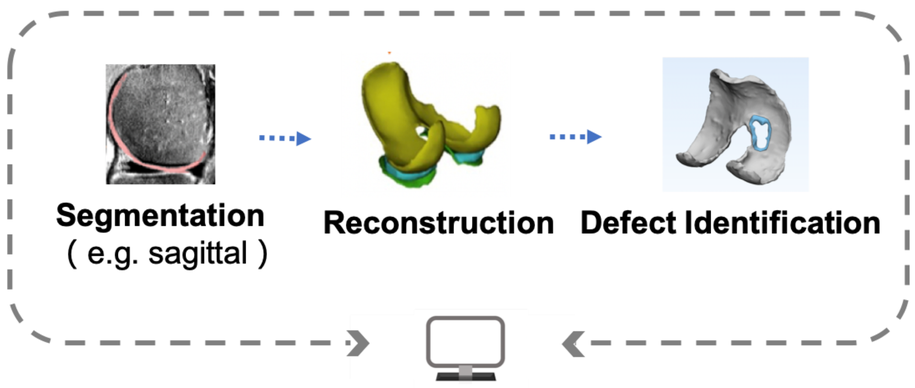
Fig.1 Stanmore Stem Cell Therapy Procedure

Method

➢ Patient Data: Pre-SSCT and Post-SSCT MRI scans.



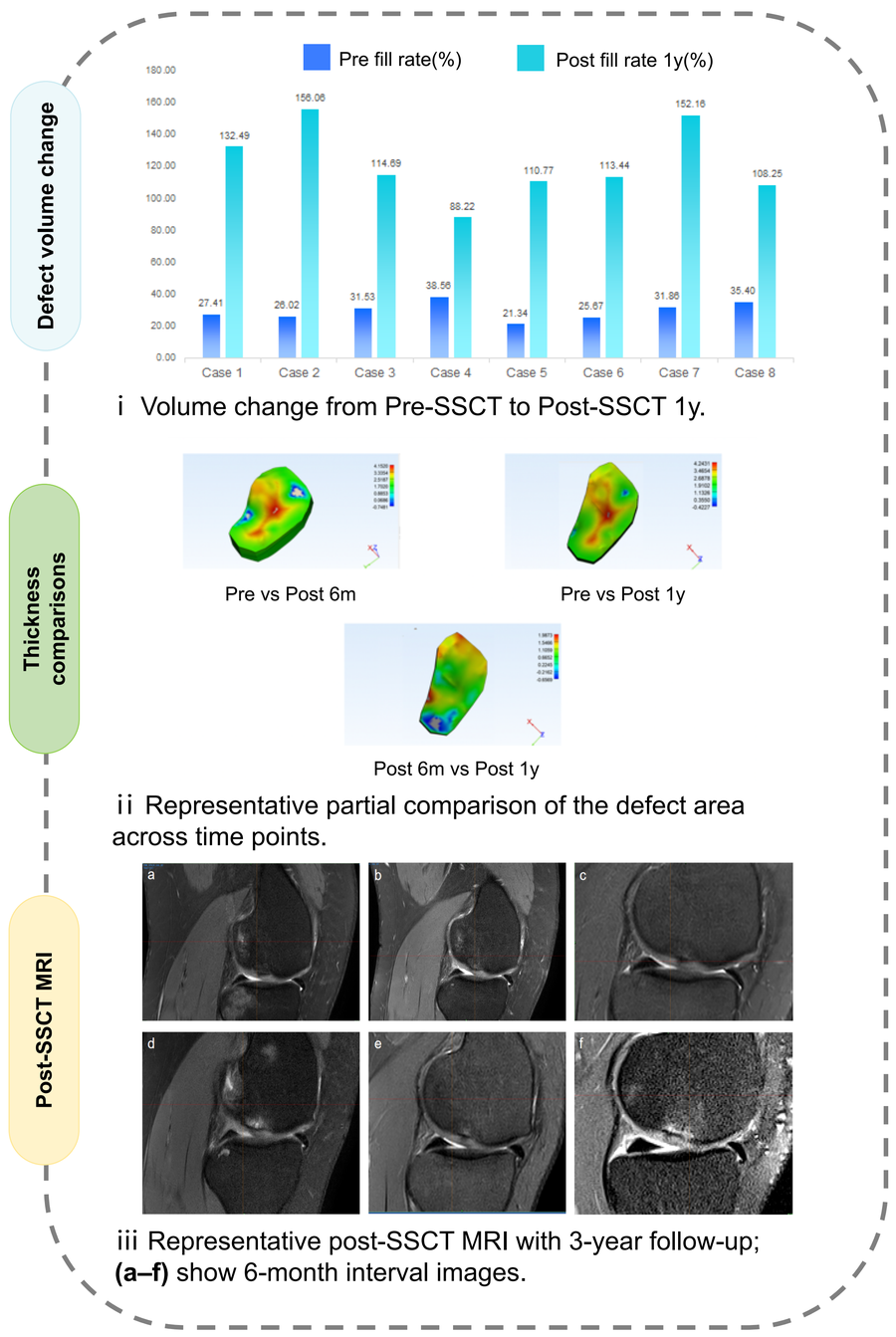
➢ Methodology:
- Segmentation
- 3D Reconstruction
- Defect Identification



➢ Objective: Accurately assess the efficacy of SSCT in enhancing knee cartilage regeneration relative to a healthy condition.

Results

- SSCT achieved measurable cartilage regeneration in all cases, with newly formed cartilage volume quantified in Fig. 2(i).
- Mean defect fill rate increased from 30.2% ± 5.4% at baseline to 122.0% ± 23.1% at 1 year, suggesting overgrowth.
- Thickness maps showed defect reconstitution, but persistent surface non-uniformity relative to adjacent cartilage.



i Volume change from Pre-SSCT to Post-SSCT 1y.

ii Representative partial comparison of the defect area across time points.

iii Representative post-SSCT MRI with 3-year follow-up; **(a–f)** show 6-month interval images.

Fig.2 Cartilage regeneration after SSCT.

Conclusions and Discussion

- This study presents an objective MRI-based pipeline for the assessment of cartilage regeneration after SSCT.
- Although volumetric restoration was observed after 1 year, surface uniformity remained limited, which may contribute to suboptimal outcomes.
- Future work will incorporate machine learning–assisted segmentation and automated uniformity metrics to improve precision, efficiency, and longitudinal assessment.

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