

Biomechanical Assessments Merged with Clinical-Biological Examinations in Patients Operated on Knee Osteotomy alone or with Meniscal Transplantation

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Summary

The efficacy of knee osteotomy alone may be improved if combined with meniscal transplantation. To investigate this, an original methodology has been developed and applied to a clinical trial, merging clinical, biological and biomechanical analyses. Preliminary results show good clinical and biomechanical outcomes, with a slightly better inflammatory profile in the presence of meniscal transplantation.

Introduction

Normal knee joint biomechanics is altered by severe varus/valgus deformities, occurring often in combination with meniscal deficit [1]. This unbalances medio-lateral load distribution at the condyles, potentially also in the antero-posterior direction, resulting in abnormal locomotion, pain, and osteoarthritis onset. In relatively young patients, knee joint osteotomy (KJO) is an effective surgery to restore normal joint alignment and motion while preserving native joint anatomy. Despite good postoperative outcomes, residual disability and pain have still been reported [1]. Additional meniscal allograft transplantation (MAT) could solve these issues, although this has not been demonstrated so far [2].

This study's aim is to evaluate in a patients cohort the efficacy of KJO alone or combined with MAT (KJO+MAT) by a novel approach which originally combines clinical, biomechanical, and biological analyses [2].

Methods

In an IRB-approved randomized controlled trial based on two equal-sized groups, 52 patients with varus or valgus knee deformity and meniscal deficit (Kellgren-Lawrence grade ≤ 3) have been recruiting for KJO or KJO+MAT. So far 9 and 8 patients have been treated, respectively.

Preoperatively and at 1, 3, 6 and 12-month follow-up, examinations included clinical scoring, and levels quantification of cartilage turnover/inflammation biomarkers (interleukin IL-8 and IL-1 β). Preoperatively and at 12-month follow-up, examinations included also gait-analysis for kinematic/kinetic evaluations during daily-living activities and MRI. An original multi-instrumental procedure was used to calculate the intersection of ground-reaction-force (GRF) with patient-specific tibial-plateau [3]. To this, motion data and image-based morphology reconstructions were combined by an established marker-set corroborated with additional bimodal 3D-printed fiduciary markers placed around the plateau rim. Depending on data distribution, Student's-t or Mann-Whitney-Wilcoxon test is used for

measurement comparison, along with Pearson's-product-moment correlation.

Results and Discussion

Severe knee varus/valgus deformity (8°- valgus / 9°- varus) and abnormal knee frontal/sagittal kinematics and kinetics were confirmed at pre-operative examinations, in addition to early stage knee osteoarthritis onset associated to general inflammatory patterns (figure 1). Before surgery, patients with milder meniscal deficit exhibited GRF intersections outside the mediolateral plateau edge (~62% mediolateral plateau width); with marked deficit, these were located outside the anterior edge (~54% anteroposterior width).

Postoperative examinations revealed an overall more normal knee realignment, with a significant reduction in the original deformity ($R=-0.7$) and abnormal intersection sites of GRF ($R=-0.6$), much closer to tibial plateau spine, together with significant functional improvements as by clinical scores and gait-analysis (Figure 1). Pre-vs-postoperative stable inflammation level was observed between the groups, most markedly in KJO+MAT by IL-1 β (figure 1).

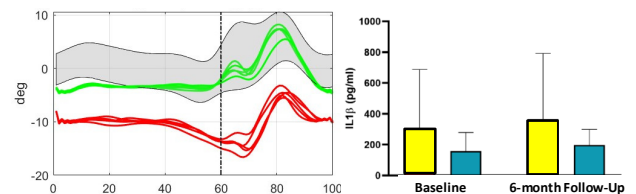


Figure 1: Knee ad/abduction (left): pre-(red) and postoperative (green) curve from a representative patient, superimposed to corresponding control patterns (grey). IL-1 β values (right): KJO (yellow box) and KJO+MAT (blue box).

Conclusions

This study provides new insight into knee deformity and realignment by an original multi-instrumental investigation. Although more data are needed, these preliminary findings show good clinical-biomechanical postoperative performance for both the groups, with slightly better inflammatory values in KJO+MAT.

Acknowledgments

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References

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