Joint Distraction in Treatment of End-stage Knee Osteoarthritis: Clinical Improvement and Structural Tissue Repair, Two year Follow-up results.

Introduction

The presently available surgical techniques for end-stage knee osteoarthritis (OA) at relatively young age, leaves sufficient room for alternatives that preserve the joint. Joint distraction is an experimental treatment for end-stage OA, aimed at unloading the joint cartilage and subchondral bone by use of an external fixation frame. Proof of concept of this technique has been demonstrated for ankle OA. Joint distraction in ankle OA proved to be clinically effective for the long term and suggested structural improvement. Since knee OA occurs more often and has a greater socio-economical impact than ankle OA, joint distraction as a therapy was applied for the knee. The present study describes the results of the first study on joint distraction (KJD).

Methods

The open, uncontrolled study included 20 patients (<60 years), with end-stage knee OA, considered for total knee replacement. Patients were treated with KJD for two months. The study was approved by the medical ethical committee (METC) of the University of Utrecht. All patients gave written informed consent.

Two monotubes with internal coil springs were placed parallel on the medial and lateral side bridging the knee joint. Each monotube was fixed to two bone pins, femoral and tibial, and distracted for 2mm. During hospitalization, distraction was extended to a total of 3mm confirmed by X-ray. Patients were encouraged to load the knee during the treatment. Each monotube was removed and flexion was practiced with use of a “continuous passive motion” device. During the treatment most patients (n=17) suffered from single or multiple pin tract infections, all being successfully treated with antibiotics.

After 2 months, tubes and pins were removed, and intra-operatively the knee was forced flexed over 90 degrees. After discharge, function was actively practiced. Maximum degree of flexion was scored every visit. Follow-up was two years. The primary clinical outcome parameter was pain and function by use of the WOMAC questionnaire. As secondary clinical outcome parameter, VAS pain score was documented. Primary structural outcome parameter was minimal joint space width (JSW) on plain standardized radiographs. Secondary structural outcome was mean JSW on X-ray and quantitative MRI parameters (one year data, two years data are presently analyzed). Additionally biochemical markers, for synthesis and breakdown of cartilage, were evaluated (one year data, two years data are presently analyzed). All structural parameters were analyzed blinded.

Results

Directly after KJD the total WOMAC score increased, from 45%±3.6 at baseline to 78%±4.8 (p<0.000; fig 1 left) at two years follow-up. This improvement was also reflected in the individual components of the WOMAC score. (WOMAC pain 76%±5.8, WOMAC stiffness 65%±6.1 and WOMAC function 78%±5.2, all p<0.001).

In concordance, the VAS pain score decreased in a similar pattern significantly as well, from 73±2.1 at baseline to 28±6.0 mm (p<0.000; fig 1 left) at two years follow-up.

Figure 1: Two year follow-up WOMAC and VAS score, two year follow-up degrees of flexion.

Maximum degrees of flexion decreased in the first three months from 121±4 degrees at baseline to 87±6.4, p<0.000 (fig 1 right) in order to recover significantly at six months (112±5.2 degrees, p<0.000). This progressive increase in degrees of flexion continues until baseline values were reached at twelve months (123±3.7 degrees, p<0.001). This total recovery maintained for at least two years, as well as the increase in WOMAC and VAS scores.

X-ray analysis depicted an increased minimum and mean. JSW from 1.0 to 1.8 mm (p<0.03; figure 2) at 2 years follow-up. Mean JSW showed similar outcome (fig 2).

Quantitative MRI analysis corroborated these results (fig 3). At one year follow-up, an increase in cartilage thickness of the affected compartment from 2.4 to 3.0 mm (p<0.01) present at both femur and tibia was observed. The total area of denuded bone decreased from 22% to 5% (p<0.01). Cartilage area and volume increased from 15.6 to 18.9 cm² and 2.3 to 2.8 cm³ (both p<0.05). Increase in cartilage area and thickness, and decrease in denuded bone area correlated with the increase in mean radiographical JSW (r=0.571, r=0.553, r=0.613 respectively, all p<0.05), at one year follow-up.

Long term changes in biomarkers showed a decrease of collagen type II breakdown marker CTXII (-11%; p<0.04) and an increase of collagen type II synthesis marker PICP (+103%; p<0.03) at one year follow-up.

The average change in ratio of PICP/CTXII of each patient was in favor of synthesis (p<0.03).

Discussion

Joint distraction in treatment of end-stage knee OA results in significant clinical improvement in pain and function, sustaining for at least two years. Designing this study, decrease of flexion after KJD was concerned, because of the stiff fixation. However, the flexion of the knee is restored completely shortly after treatment, sustaining for the period of follow-up. The significant clinical improvement is accompanied by cartilage repair, based on X-ray, MRI and biochemical marker analyses. X-rays are taken under full weight-bearing, demonstrating the mechanical competence of the formed tissue.

At present, distraction therapy is the only treatment that can reverse cartilage damage in end-stage knee osteoarthritis accompanied by significant clinical improvement.

References