INTRODUCTION

Developmental dysplasia of the hip results in a shallow hip joint that leads to early osteoarthritis (OA)[1]. By some estimates, up to 20% of hip OA could be due to this developmental disorder[2]. The cause of OA in this condition is thought to be mechanical overloading of the articular cartilage in the shallow acetabulum. Figure 1 illustrates the progression of OA over 9 years in a 30-year-old patient with untreated hip dysplasia. Pelvic osteotomies are performed to normalize the hip joint mechanics with resulting improvement in patient’s symptoms. There is increasing evidence that osteotomies are able to prevent the progression of OA[3,4]. However, careful study is difficult due to a lack of a sensitive, specific, and noninvasive technique to assess the cartilage damage in OA. The delayed Gadolinium Enhanced MRI of Cartilage (dGEMRIC) was developed to directly monitor charge density changes in articular cartilage seen in early OA. Previously, we have demonstrated that dGEMRIC is a better marker of OA than x-rays. Only dGEMRIC correlates with the patient’s symptoms and with the severity of dysplasia[5]. We have utilized dGEMRIC to investigate the hypothesis that early OA may be reversible once the mechanical abnormality in dysplastic hip joint is corrected.

MATERIALS AND METHODS

A prospective cohort study was performed. All patients were skeletally mature. Patients with neuromuscular disorder or skeletal dysplasia were excluded. Hips with prior acetabular osteotomies were excluded. Institutional review board approval and informed consent was obtained. Pre- and post-operative clinical and radiographic (x-ray and MRI) data were collected. Symptoms were assessed using the Western Ontario McMaster Universities (WOMAC) questionnaire. Standard standing anterior-posterior pelvic radiographic was obtained. Joint space width (JSW) was measured as the minimum joint distance in the radial dioresis from the center of the femoral head. Severity of arthritis on radiographic OA was graded using the Tönnis grade (0-no arthritis, 1-subchondral sclerosis, 2-mild joint space narrowing, 3-severe, localized joint space narrowing). The lateral center edge angle (LCE) measures the severity of the dysplasia and is the angle formed by the vertical line through the center of the femoral head and the edge of the acetabulum[1]. Joint subluxation was assessed using Shenton’s line. Congruency of the joint after osteotomy was simulated using pelvic radiographic with the hip abducted and internally rotated. Congruency was graded using the Yasunaga classification[6]. The dGEMRIC scans were obtained using a GE 1.5 T clinical scanner as previously outlined[5]. The average T1 value of the weight bearing femoral and acetabular cartilages was calculated and described as the dGEMRIC index.

Factors Associated with Failure after Osteotomy: A hip was considered failed if there were no improvement in post-operative WOMAC pain score, continued joint space narrowing, or worsening of symptoms necessitating a total joint replacement. We performed a logistic regression analysis to determine the pre-operative factors that are associated with failure after osteotomy.

Articular Cartilage Response to Osteotomy: The remaining non-failed hips were followed using dGEMRIC scans, post-operatively. The importance of pre-operative factor such as age, severity of dysplasia (LCE), JSW, subluxation, Tönnis grade, joint congruency, and pre-operative dGEMRIC index on the change in dGEMRIC index after surgery was assessed using multiple regression analysis. Paired t-test was performed to look at the role of a specific factor on the change in dGEMRIC index after surgery.

RESULTS

Normal Hips: Previously, we have measured the dGEMRIC index in hips with normal morphology to be 570 msec with SD of 90 msec[5].

Factors Associated with Failure after Osteotomy: 52 hips in 50 patients were included in this analysis. Average age at time of surgery was 28 years (range 11-47 years). Nine out of 52 hips failed.

Univariate analysis demonstrated that the presence of Tönnis grade 2 or 3 arthritis, low dGEMRIC index, severe dysplasia (low LCE), and presence of subluxation were associated with failure.

Logistic regression analysis confirmed that two factors, dGEMRIC index (likelihood ratio test=9.91, p=0.002) and subluxation (likelihood ratio test=6.33, p=0.012) were significantly associated with failure.

Articular Cartilage Response to Osteotomy: 44 hips in 41 patients were followed after surgery. The group as a whole had a pre-operative dGEMRIC index of 502 ± 101 msec (mean ± SD) and a post-operative dGEMRIC index of 454 ± 84 msec (p<0.01) at their 6 months-1 year follow-up scan. Regression analysis demonstrated that among factors such as age, LCE, JSW, subluxation, Tönnis grade, joint congruency, and pre-op dGEMRIC index only pre-op dGEMRIC index and Tönnis grade were significantly associated with the change in dGEMRIC index after osteotomy. When the hips were stratified into two groups: moderate OA (pre-op dGEMRIC index < 480 msec) and mild OA (pre-op dGEMRIC index = 480 msec), 14 out of 19 hips in the moderate OA group had an increase in their dGEMRIC index. Using a paired t-test, there was a borderline significant increase in dGEMRIC index in the moderate OA group (Fig 2) (p=0.08). In the mild OA group, there was a significant drop in dGEMRIC index from 575 ± 63 msec to 468 ± 99 msec (p<0.001).

DISCUSSION

The dGEMRIC index appears to be a useful metric for identifying hips that are poor candidates for osteotomy. This likely represents a level of joint damage that is irreversible. For the majority of patients, osteotomy appears to help relieve their symptoms; however, the long term effects of this procedure in preserving the joint are unknown. We have attempted to answer this question by assessing the articular cartilage before and after osteotomy utilizing MRI. In hips with mild OA, there was a decrease in dGEMRIC index after surgery, the cause of which is unknown. In the hips with moderate OA, there was a trend towards recovery of the dGEMRIC index towards the normal range; however, further study is required to understand the significance of these findings.

REFERENCES