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THE RISE AND FALL OF DGEMRIC EVALUATION IN THE ADOLESCENT HIP

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BACKGROUND: Delayed Gadolinium Enhanced Magnetic Resonance Imaging of Cartilage (dGEMRIC) was first introduced in 1996 by Bashir et al. as a method of indirectly evaluating glycosaminoglycan (GAG) changes in cartilage microstructure. Following publications originating from the Boston Children's research group describing the association of early joint failure following periacetabular osteotomy (PAO) in patients with diminished preoperative cartilage T1 relaxation values, the interest in this imaging technique spread. dGEMRIC imaging was introduced into our clinical practice in 2013 with enrollment of both pediatric and adult patients. However, since the program's apex in 2015, a marked decline in referral of adolescent patients for preoperative dGEMRIC imaging has occurred. Using data acquired during a quality analysis of the dGEMRIC program, this project was designed to investigate the utility of the dGEMRIC exam in our adolescent imaging cohort from 2013-2015 and to identify potential factors leading to decreased utilization from 2015-2018.

METHODS: IRB approval was obtained for a HIPAA-compliant, retrospective cohort study which included all patients referred for dGEMRIC from May 2013- June 2015. 108 patients/112 exams/122 hips were identified. The study was designed in 4 parts including a. Blinded quantitative imaging review x 2 performed by 4 radiologists, b. Surgical review with 2 year post-operative follow-up completed July 2017, c. Patient phone interview, and d. Financial billing and reimbursement analysis. Subsequently, dGEMRIC utilization data from July 2015-May 2018 was compiled for comparative analysis of adolescent referral patterns.

RESULTS: Of the 108 patients included in the comprehensive retrospective analysis, 56 were < 19 years of age with 43% of the adolescent patients participating in sports at time of presentation. 4 patients were excluded as the dGEMRIC data was either incomplete or could not be reprocessed. 61 hips were evaluated in the remaining 52 patients. The following summary data was compiled during the 4 part analysis. From the radiologist review: Siemens MapIt® T1 measurement software performed well at both 1.5T and 3T with good to excellent within rater ICC (0.79-0.92) but the between rater agreement was lacking particularly at 3.0T (0.45) compared to 1.5T (0.77) ($p < 0.05$). Variability between sequential T1 measurements performed by the same radiologist at 2 different time points existed averaging 36-41 ms at 1.5T and 76-84 ms at 3T. From the surgical perspective: 17 hips in 16 patients were determined to have abnormally low T1 relaxation values when reprocessed by the 4 radiologists. 1 patient's T1 values differed significantly after blinded review compared to the original interpretation. Of the 16 abnormal patients, 5 were referred for total hip arthroplasty. 7 patients underwent surgical intervention (2 PAO, 3 arthroscopic debridement/rim trim/chondroplasty/labral repair, 2 femoral/acetabular osteotomy). 1 patient was referred to rheumatology and 3 were lost to follow-up. After 2 year follow-up, all surgical patients reported decreased pain and improved function compared to presentation. From the patient perspective: 62 of the original 108 patients were contacted by phone with 60 (56%) participating in the phone survey. Patients described the dGEMRIC exam as a difficult procedure. The total time expenditure for the dGEMRIC exam averaged 3.5 hours in hospital with an average time in magnet of 107 minutes. 40% of patients reported significant pain with the pre-imaging exercise and 33% reported significant pain while in the MRI. Of 49 respondents who had undergone previous hip injections, 28 (57%) stated the dGEMRIC exam was as or more difficult than the injection. However, 50/57 (88%) stated they would undergo dGEMRIC again if the surgeon felt the information would be of added value in decision making. From the financial review, a lack of

standardization of CPT codes billed was discovered resulting in discrepant billed charges varying by a factor >10 (\$2300-\$24,000). Following completion of the quality analysis and review of the results with the referring orthopedists, only 17 dGEMRIC exams have been performed in the adolescent age group in the subsequent 36 months.

CONCLUSIONS: While the dGEMRIC exam holds promise as a prognosticating tool to guide surgical planning, in the adolescent practice environment, our historical data reveals that even when faced with abnormal T1 relaxation values, surgeons may opt to proceed with hip sparing surgical procedures simply because of the young age of the patient. From the radiologist's perspective, dGEMRIC reporting is clouded by measurement variability. Inherent variability in the numbers reported brings to question the wisdom of using absolute T1 numeric thresholds to prognosticate joint failure risk. From the patient's perspective, this imaging test comes with significant cost measured by time, pain, and financial burden. For all these reasons, utilization of this imaging study should be limited to the select few adolescent patients in whom documentation of an abnormal cartilage T1 value alone could substantially impact the surgical plan.

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