Early Experience With a Comprehensive Hip Preservation Service Intended to Improve Clinical Care, Education, and Academic Productivity

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Abstract

Background The field of hip preservation surgery has grown substantially over the past decade. Although open hip procedures reportedly relieve pain and restore function, arthroscopic treatment has increasingly become a reasonable alternative. In 2008, we formed a comprehensive hip preservation service (HPS) to address clinical, educational, and research needs.

Questions/Purposes We compared (1) volume, type, and corresponding improvement in pain and function of open and arthroscopic treatments; (2) orthopaedic resident test performance; and (3) academic productivity before and after creation of the HPS.

Methods We retrospectively reviewed 212 patients undergoing 220 open procedures from 1996 to 2007 (Group 1) and 260 patients undergoing 298 procedures (153 open, 145 arthroscopic) from 2008 to May 2010 (Group 2). At each clinic visit, we recorded Harris hip score (HHS) and conversion to THA. Minimum followup was 1 year for Group 1 (mean, 4 years; range, 1–13 years) and Group 2 (mean, 1.5 years; range, 1–3 years). We

compared orthopaedic resident performance on two standardized tests and the number of academic works (publications, book chapters, electronic media) and peer-reviewed grants funded before and after creation of the HPS.

Results Mean HHS improved from 63 to 90 in Group 1 and from 76 to 91 in Group 2. Rate of conversion to THA was similar between groups despite expansion of surgical volume. Standardized orthopaedic resident test performance improved. Academic productivity as measured by publications and grant funding was facilitated by the HPS.

Conclusions Early experience with a multidisciplinary HPS was positive; it facilitated clinical volume expansion while maintaining improvement in pain and function in young adults. Additional benefits included educational and academic productivity gains.

Level of Evidence Level IV, therapeutic study. See Instructions for Authors for a complete description of levels of evidence.

Introduction

The field of hip preservation surgery has grown substantially over the past decade, coincident with the recognition that most hip problems in young adults are associated with altered hip morphology [5, 25, 30, 34]. Although open hip procedures, such as surgical dislocation [10, 13, 29, 34] for femoroacetabular impingement (FAI) and periacetabular osteotomy (PAO) [8, 23, 28, 35] for acetabular dysplasia, reportedly improve pain and function [8, 13], arthroscopic treatment has become a reasonable alternative to open hip approaches [7, 11, 16, 17, 20, 24, 30, 32, 33]. Arthroscopic treatment of hip disorders, such as labral injury and FAI, has increased dramatically over the past 5 years, and results indicating improvement in pain and function, as

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measured predominately with the Harris hip score (HHS), have been reported [7, 11, 16, 20, 24, 30]. Nevertheless, the question of whether early surgical treatment of structural hip abnormalities delays or prevents hip osteoarthritis remains largely unanswered.

Additional questions regarding the indications and corresponding improvement in pain and function of open versus arthroscopic procedures for specific intra- and extraarticular hip abnormalities are of current interest to hip preservation surgeons. Moreover, the rapid growth of hip preservation surgery has motivated questions regarding effective models of clinical care, education, and academic activity. Traditional clinical care models have consisted of institutions or surgeons providing only one specific operative approach for most hip preservation indications. More recently, others have utilized a multidisciplinary approach based on the extent or severity of hip pathomorphology or surgeon skill set. In 2008, our center established a comprehensive hip preservation service (HPS) bringing together surgeons with specific skill and interest in open and arthroscopic treatment of the hip. The clinical goal of the HPS was to refine operative indications via creation of a treatment algorithm and measurement of clinical outcomes. Additional goals of the HPS were to provide a more structured forum (weekly conference) for didactic and case-based education of orthopaedic trainees and to foster clinical research and basic science research related to experimental engineering mechanics and motion analysis of the hip.

To measure the effectiveness of the HPS in terms of clinical care, education, and academic productivity, we determined the following: (1) type and volume of operative interventions, (2) improvement in pain and clinical function and failure rate (defined as conversion to THA) resulting from operative treatments (open and arthroscopic), (3) orthopaedic resident performance on standardized tests, and (4) amount of academic productivity specific to hip preservation in terms of publications and grant funding or submission before and after creation of the HPS.

Patients and Methods

All clinical data were collected prospectively in a computerized database (Filemaker Pro, Santa Clara, CA, USA). We reviewed all patients who underwent hip preservation operations with complete clinical data before creation of the HPS (1996 to 2007) (Group 1). A wide range of pathology, including acetabular dysplasia, FAI, labral injury, Legg-Calvé-Perthes disease, slipped capital femoral epiphyses, and other sequelae of pediatric hip disease, was treated. During this period, the primary treatment methods

Table 1. Demographic information

Variable	Group 1	Group 2	p value
Number of patients	212 (45%)	260 (55%)	
Number of hips	220 (42%)	298 (58%)	
Sex (number of hips)			0.19
Male	92 (42%)	142 (48%)	
Female	128 (58%)	156 (52%)	
Age (years)*	28 ± 9	28 ± 11	0.53
BMI*	26 ± 6	25 ± 5	0.76
Followup (years) [†]	4 (1–13)	1.5 (1–3)	< 0.001

* Values are expressed as mean ± SD; [†]values are expressed as mean, with range in parentheses.

were open techniques, such as surgical dislocation, open anterior hip débridement, PAO, and femoral osteotomy. Hip arthroscopy was used sparingly during this time period and not included in this data set. In 2008, hip arthroscopy was formally incorporated into the HPS, and we reviewed all patients who underwent either open or arthroscopic treatment of the hip after creation of the HPS (2008 through May 2010) (Group 2). We evaluated 472 patients with 518 surgical procedures: 212 patients undergoing 220 open procedures (Group 1) and 260 patients undergoing 298 procedures (153 open, 145 arthroscopic) (Group 2). Patient demographics were generally similar for the two groups (Table 1). Eleven patients who underwent surgical dislocation, 14 patients who underwent PAO, and seven patients who underwent hip arthroscopy were lost to followup. Reasons for loss to followup were loss of contact information due to relocation or failure to return for or communicate followup with outside referring physicians. Given our practice location, many patients travel for surgical care from neighboring states. Minimum followup was 1 year for Group 1 (mean, 4 years; range, 1–13 years) and Group 2 (mean, 1.5 years; range, 1–3 years). No patients were recalled specifically for this study; all data were obtained from medical records and radiographs.

Clinical outcome of operatively treated patients was assessed with the HHS [14, 18]. Failure, as defined by conversion to THA, was determined in both groups. In general, patients were seen in followup 2 to 6 weeks after surgery, at 6 months, and annually thereafter. At each followup visit, patients were assessed clinically using the HHS and radiographically with AP pelvic and multiple lateral radiographs. A team member other than the operating surgeon performed the clinical outcome measures.

A weekly multidisciplinary indications conference was also initiated in 2008, in which all potentially operative hip preservation cases were formally presented and discussed and literature review of salient hip preservation articles was undertaken. Surgeons, fellows, residents, physician assistants, nurses, and researchers attending the conference

represented various orthopaedic subspecialties, including adult reconstruction, sports medicine, pediatric orthopaedics, musculoskeletal radiology, and primary care musculoskeletal medicine. The five goals of the conference were to (1) establish a consistent protocol for the assessment of the nonarthritic painful hip (history, physical examination, imaging, etc); (2) ensure the appropriate diagnosis leading to a surgical intervention; (3) discuss treatment options and select the appropriate treatment methodology based on the pathomorphology of the individual hip; (4) foster hip preservation education for residents, fellows, allied health providers, and researchers; and (5) provide a forum for community participation such that surgeons from surrounding hospitals could present challenging cases and receive feedback. There were generally 12 to 20 patients discussed at each conference. The discussion was focused on identifying the underlying hip structural abnormality, associated chondrolabral damage in the hip, appropriate clinical workup, including imaging, and appropriate treatment methodology.

To assess the educational benefit of the HPS, we retrospectively reviewed the orthopaedic resident performance on the lower extremity (pelvis, hip joint, femur) domain from the American Board of Orthopaedic Surgery (ABOS) Part I examination and in their final year of training on the Orthopaedic In-Training Examination (OITE) before and after creation of the HPS.

To assess the academic benefits of the HPS, we determined the number of academic works (publications, book chapters, electronic media) and the number of peer-reviewed grants funded before and after creation of the HPS.

Independent two-tailed t-tests were used to compare continuous variables between the groups. Dichotomous variables were analyzed with Fisher's exact test. To verify for a provider effect, a modified Poisson regression was performed. Kaplan-Meier survivorship analysis was performed with failures defined as conversion to THA. We used a log-rank survival test to analyze survivability from index hip preservation procedure to THA. Potential confounders were identified as age, sex, BMI, diagnosis, procedure, procedure type (open versus arthroscopic), provider, and Tönnis grade. The OITE scores for residents were evaluated for variance with an F test, after which an independent two-tailed t-test for equal variances was performed. We analyzed the data using STATA® Version 12 statistical analysis software (StataCorp LP, College Station, TX, USA).

Results

The two cohorts were similar in age, sex, and BMI (Table 1) but varied in diagnosis ($p < 0.001$), procedure

Table 2. Surgical procedures and diagnoses

Variable	Group 1	Group 2	p value
Primary procedure (number of hips)			
Osteochondroplasty/labral repair or débridement	86 (39%)	190 (64%)	< 0.001
Periacetabular osteotomy	116 (52%)	64 (21%)	< 0.001
Other	18 (9%)	44 (15%)	
Primary diagnosis (number of hips)			
Impingement	86 (39%)	259 (87%)	< 0.001
With labral injury	10	75	
Without labral Injury	76	184	
Dysplasia	95 (43%)	37 (12%)	< 0.001
Other	39 (18%)	2 (1%)	

Table 3. Clinical and radiographic outcomes

Variable	Group 1	Group 2			p value
		Total	Open	Arthroscopic	
Time to THA (years)*	3 ± 3	1 ± 1			< 0.001
Conversion to THA (number of hips)	25/220 (11%)	8/298 (3%)	3	5	< 0.001
Mean HHS total (points)					
Preoperative	64	57	64	57	0.002
Postoperative	89	78	89	77	< 0.001
Mean HHS pain (points)					
Preoperative	26		30	NA	0.43
Postoperative	40		40	NA	1.00
Mean HHS function (points)					
Preoperative	31		31	NA	1.00
Postoperative	41		47	NA	0.40
Tönnis grade (number of patients)†					0.003
0	57 (37%)		53 (59%)	NA	
1	74 (48%)		26 (29%)	NA	
2	23 (15%)		11 (12%)	NA	

* Values are expressed as mean ± SD; †Tönnis grades were missing for some patients; HHS = Harris hip score; NA = not available.

($p < 0.001$), and procedure type ($p < 0.001$) (Table 2) and Tönnis grade ($p = 0.003$) (Table 3). Of the 154 patients in Group 1 with Tönnis grades available, 97 were classified as having either Tönnis Grade 1 ($n = 74$) or 2 ($n = 23$) arthritic changes, while only 37 of the 90 patients in

Group 2 with Tönnis grades available had a Tönnis grade of 1 ($n = 26$) or 2 ($n = 11$) (Table 3). There was also a provider effect in Group 2 ($p < 0.001$) for diagnosis and procedure. Additionally, five of eight patients in Group 2 had undergone arthroscopic intervention as their index procedure.

In Group 1, the HHS for all open procedures improved from a preoperative value of 63 to a postoperative value of 90 (Table 3). In Group 2, the HHS for open and arthroscopic procedures improved from a preoperative value of 76 and 61, respectively, to postoperative values of 91 and 86, respectively (Table 3).

The survival rates at 1-year followup for Groups 1 and 2 were 95% and 94%, respectively (Fig. 1). Interestingly, the survivor rates at 2 years were 89% and 94%, respectively. There was no difference ($p = 0.68$) in the number of patients converting to THA between Group 1 ($n = 25$) and Group 2 ($n = 8$) (Table 3).

The OITE scores revealed residents in Group 2 achieved a higher percentile ranking ($p = 0.02$) than those in Group 1 (87% versus 72%). In addition, the lower extremity (pelvis, hip joint, femur) domain of the ABOS Part I examination scores revealed a positive trend beginning in 2008 to one SD above the mean in 2010 (Fig. 2).

From 1996 to 2007, six original peer-reviewed manuscripts specific to hip preservation were published and five grants in hip preservation were funded over 12 years for a rate of 0.4 grants/year. After creation of the comprehensive HPS, 15 original peer-reviewed manuscripts, four book chapters, and five published electronic media topics were published. Twenty additional active projects are awaiting completion for publication (totaling 44 projects). Five additional grants were funded in 3 years (2008–2010), a rate of 1.7 grants/year.

Discussion

As the field of hip preservation has undergone rapid expansion, establishing improved clinical care, research, and education models has been important to the community of physicians providing care to young adult patients with painful hip conditions. Our aim was to describe the positive effects derived from the development of a comprehensive HPS and an organized didactic conference focusing on hip preservation. Specifically, we determined the following: (1) type and volume of operative interventions, (2) improvement in pain and clinical function and failure rate (defined as conversion to THA) resulting from operative treatments (open and arthroscopic), (3) orthopaedic resident performance on standardized tests, and (4) amount of academic productivity specific to hip preservation in

Fig. 1 Kaplan-Meier survival rates and their corresponding 95% CIs, with failure defined as conversion from index hip preservation procedure to THA, are shown for Groups 1 and 2. The number of patients available for followup at the corresponding intervals for conversion to THA can be found under the graph.

Fig. 2 A graph shows the SDs of the mean scores of the orthopaedic residents in the lower extremity (pelvis, hip joint, femur) domain from the ABOS Part I examination by year.

terms of publications and grant funding or submission before and after creation of the HPS.

Because we examined the implementation effects of a new care model from a clinical, research, and educational perspective, there were a number of limitations. First, and perhaps most importantly, in terms of impact on clinical care, because our report is limited to observations from two different time periods, we cannot directly prove pain and

Fig. 3 A flowchart illustrates our general hip preservation treatment algorithm. FAI = femoroacetabular impingement; OA = osteoarthritis; PAO = periacetabular osteotomy; SCFE = slipped capital femoral epiphysis; MHE = multiple hereditary exostoses. Simple

morphology = femoral cam deformity limited to anterolateral femur, anterior focal acetabular overcoverage. Complex morphology = femoral cam deformity with lateral/posterior extension, global acetabular overcoverage.

clinical function improvement was related to the HPS. We demonstrated mean improvement in HHS postoperatively for both groups before and after creation of the HPS (Table 3). Nevertheless, the fact that mean clinical outcome improvement was maintained while the service was substantially expanded with the addition of arthroscopic interventions is, in and of itself, an encouraging finding. Second, although we have demonstrated an improvement in orthopaedic resident test performance specific to the hip and pelvis knowledge domain after institution of the HPS, we do not account for confounding variables such as improvement in individual resident aptitude and interest over time and overall educational improvements in our residency program. Also, we have not demonstrated similar measurable knowledge improvement at the fellow or non-surgical physician level although our clear impression is that conference attendees at all levels have benefited from the increased hip preservation exposure provided from the conference. Third, the demonstration of increased academic productivity after creation of the hip service is confounded by the fact that recruitment of motivated researchers (both clinical and basic science) occurred simultaneously with development of our program; thus, the productivity gains are likely multifaceted in nature.

Before 2008 at our institution, hip conditions such as developmental hip dysplasia and FAI were treated with

predominantly open techniques. During this time, improvement in hip pain and clinical function, as measured by the HHS, was demonstrated (Table 3). Hip arthroscopy was formally incorporated into the HPS in 2008, and subsequently we have demonstrated continued pain and function improvements for both groups, indicating at least, despite service expansion, clinical outcome improvement has been maintained. Based on multiple clinician input, a treatment algorithm (Fig. 3) served as a basic template for discussion of individual cases and focused on the underlying hip structural abnormality rather than labral injury alone. This concept has been associated with improved clinical outcomes [1, 5, 9, 12, 19, 27]. Additionally, the Kaplan-Meier survivorship analysis suggests hip preservation survivability may be improving after implementation of the HPS. However, this is limited by followup at this time and further research is needed to monitor this trend (Fig. 1). Expansion of clinical volumes may have indicated tailoring operative treatment to the type and extent of hip pathomorphology and chondrolabral damage is a valid concept [1, 4, 6, 21, 22, 26, 31, 36].

The HPS also provided a structured forum for educational activity related to the field of hip preservation. Although it is difficult to directly measure the educational benefit of the HPS to all participants, we found improvement in orthopaedic resident performance on the OITE and the lower extremity domain of ABOS Part I examination. Given the

current rapid expansion of hip preservation surgery, particular emphasis on improving educational curricula related to hip preservation would seem to be prudent at this time [33]. A key component of this has been creation of a multidisciplinary hip preservation conference. Presentation of clinical and didactic material in this forum facilitated the exchange of information between other treating and collaborating physicians. Additionally, the scheduled meeting provided dedicated time for clinicians and researchers to meet. This venue facilitated exchange of ideas and enhanced the development and execution of translational research.

An additional goal of the comprehensive HPS was to facilitate clinical and basic science research collaboration. An established clinical and basic science research relationship focusing on the principles of computational and experimental engineering mechanics, motion analysis, and imaging to solve unique problems related to hip pathomorphology was similarly improved [2, 3, 15, 27]. We observed an increase in research activity, including an increase in peer-reviewed publications, projects in progress, and funded research grants, in the 3 years after creation of the HPS. We believed creating an educational environment focusing on a relatively new and exciting field of orthopaedics energized clinicians and researchers to ask important questions and think about strategies to test clinically relevant hypotheses.

In summary, the experience of creating a comprehensive service to address the new and growing demand for joint preservation has raised as many questions as it has answered. Refinement of pathogenetic mechanisms, diagnostic protocols, and operative indications is needed. Similarly, defining better models of surgical education and training offers great potential for advancement of the field. Our experience has shown a multidisciplinary approach to caring for young adult patients who desire symptom improvement and preservation of the native hip is positive and associated with the added benefits of enhanced trainee education and group academic productivity.

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