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Costs of open, arthroscopic and combined surgery for developmental dysplasia of the hip

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ABSTRACT

A variety of options exist for management of patients with developmental dysplasia of the hip (DDH). Most studies to date have focused on clinical outcomes; however, there are currently no data on comparative cost of these techniques. The purpose of this study was to evaluate in-hospital costs between patients managed with periacetabular osteotomy, hip arthroscopy or a combination for DDH. One hundred and nine patients were included: 35 PAO + HA, 32 PAO and 42 HA. There were no significant differences in the demographic parameters. Operative times were significantly different between groups with a mean of 52 min for PAO, 100 min for HA and 155 min for PAO + HA, ($P < 0.001$). Total direct medical costs were calculated and adjusted to nationally representative unit costs in 2017 inflation-adjusted dollars. Total in-hospital costs were significantly different between each of the three treatment groups. PAO + HA was the most expensive with a median of $21 852, followed by PAO with a median of $15 124, followed by HA with a median of $11 582 ($P < 0.001$). There was a significant difference between outpatient median costs of $11 385 compared with $24 320 for inpatients ($P < 0.001$). Procedures with greater complexity were more expensive. However, a change from outpatient to inpatient status with HA moved that group from the least expensive to similar to PAO and PAO + HA. These data provide an important complement to clinical outcomes reports as surgeons and policymakers aim to provide optimal value.

INTRODUCTION

Although there is variability regarding the incidence of developmental dysplasia of the hip (DDH), approximately 1 in 1000 people are born with a dislocated hip and 1 in 100 people have congenital hip subluxation [1, 2]. Normal hips have a lateral center-edge angle (LCEA) of >25°. An LCEA of 20°–25° indicates borderline dysplasia and an LCEA <20° indicates dysplasia [3–5]. While there are many contributing factors leading to DDH, females are affected at a higher rate [1, 2]. DDH often causes pain and discomfort, and can lead to more serious complications such as subluxation or secondary osteoarthritis requiring early total hip arthroplasty (THA) [2, 6–9]. The onset and severity of symptoms depend on many variables such as obesity, activity level and family history [3, 4, 10, 11]. When patients with symptomatic DDH fail to respond to conservative treatments such as activity modification or physical therapy, surgical management can be considered. The gold standard open technique for correction of DDH in the non-arthritic patient remains a periacetabular osteotomy (PAO) [4, 6]; however, these patients are increasingly being managed with hip arthroscopy (HA) when the deformity is mild or borderline. Furthermore, some surgeons are adding HA to the PAO. HA seems to be beneficial because it is less invasive and allows the surgeon to inspect and/or address any other intra-articular pathologies such as a torn labrum that can commonly occur with symptomatic hip dysplasia, but its absolute necessity at the time of PAO is controversial [4, 6, 7, 12, 13]. While debate also remains over the definition of 'mild dysplasia', some literature suggests that DDH with an LCEA 18°–25° may benefit from treatment with focus on soft tissue repair and stabilization through HA, while addressing capsular laxity, if present, with the use of capsular plication [13, 14]. However, there is broad consensus that LCEA <18° represents under-coverage that is most reliably addressed with an osteotomy such as PAO [3, 4, 7, 11]. PAO is also indicated when there is symptomatic hip instability or a need for acetabular reorientation leading to femoracetabular impingement or other biomechanical abnormalities [3, 4]. While PAO, HA or a combined PAO + HA can theoretically address mild DDH, the goal of each is to improve pain along with the natural history of the native hip. In particular, surgery aims to avoid or delay subsequent THA in young patients who are at a higher risk of arthroplasty failure or revision in the future [3, 6, 7, 11].

To date, major studies examining DDH and comparing treatments have focused on clinical outcomes [12, 15]. There are currently no data on comparative costs of these techniques. In the changing landscape of healthcare reimbursement, cost analyses require careful attention to optimize value [14, 15].With the increased scrutiny being given to value-based care in the modern healthcare landscape, it is imperative that we understand costs associated with treatments as well as their clinical outcomes to focus on delivering the highest relative quality [16–18]. The purpose of this study was to evaluate total in-hospital cost of care between patients managed with PAO, HA or combined PAO and HA for DDH [6, 11, 19, 20].

MATERIALS AND METHODS

Following institutional review board approval, internal institutional databases and the electronic medical record were queried for all patients who underwent surgical management for DDH from 2015 to 2017 at a single high-volume academic institution. All cases were managed by one of four hip preservation surgeons, two of which have adult reconstruction fellowship training and two of which have sports medicine subspecialty training. We identified 32 patients who underwent PAO only, 42 who underwent HA only and 35 who underwent PAO + HA. Mean age of the entire cohort was 28 (range, 15–48), 77% were female and mean body mass index (BMI) was 25 kg/m^2 (range, 16–39) (Table I). There were no significant differences in the demographic parameters between groups.

Operative times were significantly different between groups with a mean of 52 min for PAO, 100 min for HA and 155 min for PAO + HA ($P < 0.001$) (Table I). While there was no difference between groups in the proportion of patients with Tönnis 0 osteoarthritis (61% overall), the severity of DDH was significantly different between groups. Patients in this study who underwent PAO alone were significantly more dysplastic than their HA or combined counterparts. The mean LCEA was 14° for PAO only, 22° for HA alone and 17° for PAO + HA ($P < 0.001$). Additionally, the HA alone group had significantly more boney coverage as measured by the Tonnis angle preoperatively (Tonnis HA 9° vs PAO 20°, and combined 13°, $P < 0.001$).

Resource analysis

Direct medical costs were calculated using a previously described methodology at the line-item detail level by internal resident review [18]. Generalizable, standardized medical costs were calculated for each line-item and then standardized to 2017 inflation-adjusted dollars. Part A items, which consisted of hospital-billed services and procedures, were valued by multiplying billed charges by individual year and cost center-specific cost-to-charge ratios (obtained from Medicare cost reports). Part B services that are primarily services billed by physicians were valued using national average Medicare reimbursement rates. Patient characteristics and costs are presented as means ± standard deviations (SDs), medians with interquartile ranges (IQR), and frequencies and percentages.

Statistical analysis

Descriptive statistics were performed as appropriate with continuous variables reported as means and ranges and categorical variables as counts and percentages. Nonparametric comparisons were performed using Mann–Whitney tests for comparison of two groups and Kruskal–Wallis tests for comparisons of more than two groups. Significance was set at $\alpha < 0.05$. Statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC, USA) and R version 3.4.0 (R Core Team, Vienna, Austria).

RESULTS

Total in-hospital costs were significantly different between each of the three treatment groups. PAO + HA group was the most expensive with a median of $21 852 (range, $19 863–$37 486), followed by PAO with a median of $15 124 (range, $14 427–$17 020), followed by HA with a median of $11 582 (range, $10 690–$12 974) ($P < 0.001$) (Table II). The same relationship was observed for both Part A hospital services and Part B professional costs ($P < 0.001$) (Table II). Specifically, Part A costs were highest among the combined group with a median of $18 510 (range, $16 983–$31 331) followed by PAO with a median of $12 992 (range, $12 209–$14 761) and followed by HA

Table I. Demographics and preoperative radiographic measurements of hip dysplasia patients

Variable	*PAO + HA* (n = *35 pts*)	*PAO* (n = *32 pts*)	*HA* (n = *42 pts*)	P-*value*
Age (range)	27 (15–41)	29 (15–41)	27 (13–48)	0.2470
Sex, Female	30 (86%)	28 (88%)	26 (62%)	0.5488
BMI (kg/m^2) (range)	25 (16–38)	24 (18–39)	25 (17–39)	0.4165
Operative time, min (range)	155 (111–320)	52 (44–68)	100 (43–235)	<0.001
Tönnis Grade 0	20 (57%)	26 (81%)	21 (50%)	0.4086
LCEA (range)	17° (−3°–25°)	14° (0°–23°)	22° (18°–25°)	<0.001
Tönnis angle (range)	13° (5°–28°)	20° (7°–35°)	9° (2°–15°)	<0.001

LCEA, lateral center-edge angle; BMI, body mass index; PAO, periacetabular osteotomy; HA, hip arthroscopy.

Table II. Hospital costs of hip dysplasia patients based on procedure

Variable	*PAO + HA* (n = *35 pts*)	*PAO* (n = *32 pts*)	*HA* (n = *42 pts*)	P-*value**
2017 adjusted costs, median (IQR)				
Total in-hospital cost	$21 852	$15 124	$11 582	<0.001
	(19 863–37 486)	(14 427–17 020)	(10 690–12 974)	
Part A hospital services	$18 510	$12 992	$9 363	<0.001
	(16 983–31 331)	(12 209–14 761)	(8475–10 450)	
Part B professional costs	$3342	$2222	$2229	<0.001
	(3006–6154)	(2077–2339)	(2154–2693)	

IQR, interquartile range; PAO, periacetabular osteotomy; HA, hip arthroscopy.
**P*-values for all three pairwise comparisons.

alone with a median of $9363 (range, $8475–$10 450). For Part B services combined PAO + HA had a median cost of $3342 (range, $3006–$6154), followed by HA alone with median a cost of $2229 (range, $2154–$2693) and PAO alone with a median cost of $2222 (range, $2077–$2339) (Table II).

Among the 42 HA patients, 38 were treated as outpatients and 4 as overnight observation as they were performed later in the day. There was a significant difference between groups based on hospital stay with outpatients having a median cost of $11 385 (range, $10 669–$12 373) compared to $24 320 ($20 041–$35 866) for inpatients ($P < 0.001$) (Table III).

DISCUSSION

Mild dysplasia can be managed with either PAO, HA or a combination of both procedures. HA focuses on addressing impingement, intra-articular pathology, and concomitant soft tissue laxity, whereas PAO is based on the principal of correcting femoral head under-coverage in the young dysplastic patient who has failed conservative therapy [3, 7, 14, 21]. There are also several factors that go into choosing which surgical intervention is performed. Some mild DDH patients may actually have impingement and would benefit from HA, some patients simply do not want a PAO and some surgeons may feel that a PAO in not warranted in mild DDH. Furthermore, some patients have both intra-articular pathology as well as acetabular morphology that is treated through a combination of PAO and HA [6, 12, 15]. Prior literature with this unique cohort has focused primarily on clinical and radiographic outcomes; however, the cost associated with these individual treatment cohorts has yet to be considered. Our study demonstrates that combined procedures and those requiring overnight

Table III. Hospital costs of patients receiving hip arthroscopy based on inpatient vs outpatient care

Variable	*HA* (n = *42 pts*)	*Outpatient HA* (n = *38 pts*)	*Inpatient HA* (n = *4 pts*)	P-*value**
2017 Adjusted Costs, median (IQR)				
Total in-hospital cost	$11 582	$11 385	$24 320	<0.001
	(10 690–12 974)	(10 669–12 373)	(20 041–35 866)	
Part A hospital services	$9363	$9228	$20 062	<0.001
	(8475–10 450)	(8412–9881)	(16 450–29 510)	
Part B professional costs	$2229	$2215	$4258	<0.001
	(2154–2693)	(2153–2329)	(3591–6356)	

IQR, interquartile range; HA, hip arthroscopy.
*Pairwise comparison of outpatient HA vs inpatient HA.

observation or formal inpatient stays lead to increased cost during the hospital episode of care for these hip preservation procedures. While cost is important, it should not supersede performing the proper surgical intervention based on the patient symptoms and underlying pathology.

HA was the least expensive treatment option despite a significantly longer operative time compared with PAO. This was largely associated with the distinction between outpatient and inpatient costs outweighing the additional costs of longer OR time and surgical personnel cost. In a small subset of patients who had conversion of outpatient HA to inpatient status (4 out of 42 patients), the median cost for the hospital episode of care was similar to the PAO and PAO + HA cohorts (Table III). In the era of cost-consciousness as a means to deliver value-based healthcare to patients, this suggests that HA cases should endeavor to be scheduled earlier in the day to avoid potentially drastically increased costs associated with an inpatient stay for a procedure where outpatient treatment is routine [16, 17].

Additionally, there is a significantly increased cost for the majority of patients who underwent the combined procedure. Specifically, the cost of PAO + HA was a median $6728 more expensive than PAO alone and a median $10 270 more expensive than HA alone. As we did not evaluate outcomes data in this study, we cannot conclude which procedure or combination of procedures is best. However, in the era of value-based healthcare, policymakers, insurance companies and hospital systems will place increased emphasis on comparative cost of procedures in the context of comparative outcomes. This will be especially poignant for procedures for which clinical outcomes are shown to be similar, in which case it is likely that more expensive procedures will face amplified scrutiny [22, 23]. Currently, there are limited data regarding the necessity of combined procedures in the case of mild DDH [12, 24, 25].

This study is not without limitations. Outside of the retrospective nature of the study, the cost analysis comes from a single institution's data with a small overall sample size that does not focus on external portions of care such as rehabilitation costs. While costs are thought to generally be similar between institutions, differences between academic and private practice as well as variation in practice models will limit generalizability. Further limiting factors such as location of study and broader applicability across non-American healthcare systems should also be considered. Additionally, further patient cost factors such as caregiver requirements for same day discharge or overnight care outside the hospital episode of care exist and could influence overall experienced cost.

CONCLUSION

This study defines the in-hospital costs associated with the three of the most common techniques for surgical management of DDH. As expected, procedures with greater complexity were more expensive. However, hospital stay was identified as a greater driver of cost than additional OR time for increased procedure complexity. This was most poignantly demonstrated in patients undergoing HA alone, where a change from outpatient to overnight observation altered this group from the least expensive to on par with the other traditionally inpatient procedures. These data provide an important complement to clinical outcomes reports as surgeons and policymakers aim to provide optimal value for management of elective surgical conditions.

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