

Long-term patient-centred outcomes of periacetabular osteotomy in a large consecutive series

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Aims

We assessed the long-term outcomes of a large cohort of patients who have undergone a periacetabular osteotomy (PAO), and sought to validate a patient satisfaction questionnaire for use in a PAO cohort.

Methods

All patients who had undergone a PAO from July 1998 to February 2013 were surveyed, with several patient-reported outcome measures (PROMs) and radiological measurements of preoperative acetabular dysplasia and postoperative correction also recorded. Patients were asked to rate their level of satisfaction with their operation in achieving pain relief, restoration of activities of daily living, ability to perform recreational activity, and their overall level of satisfaction with the procedure.

Results

A total of 143 PAOs were performed between 1998 and 2013. Of those, 90 postoperative surveys were returned. Only 65 patients (73 hips) had both pre- and postoperative radiographs available for measurement. The mean time to follow-up was 15 years (6.5 to 20). Most patients were female (91%), with a mean age of 26.4 years (14.9 to 48.3) at the time of their surgery. A statistically significant improvement in radiological correction was detected in all hips ($p < 0.001$). A total of 67 patients (92.3%) remained either very satisfied or satisfied with their PAO. The internal consistency of the patient satisfaction questionnaire, measured using Cronbach's α , ranged from 0.89 to 0.94 indicating 'good' to 'excellent' reliability.

Conclusion

Outcomes of importance to patients undergoing a PAO include several key domains: pain relief, improve activities of daily living, and improve recreational ability. Our study demonstrates high rates of long-term patient satisfaction in all domains, and found the patient satisfaction questionnaire to be a valid and reliable instrument for use in this cohort.

Take home message

- We present a validated long-term patient satisfaction survey alongside traditional outcome measures for a large periacetabular osteotomy cohort.

Introduction

Young patients with symptomatic hip pain and established arthritis have few surgical options other than total hip arthroplasty (THA). Younger patients undergoing THA are reported to have a higher lifetime risk of

revision than older patients. While patients over the age of 70 years have a lifetime risk of revision of 5%, with no difference between sexes, the lifetime risk of revision for patients under the age of 50 years is 35% for men and 20% for women.¹ Other long-term studies report a survival rate as high as 63% at ten years.²

The goal of the Bernese periacetabular osteotomy (PAO) is to correct deficient acetabular coverage in hips with developmental dysplasia to prevent or decelerate

secondary osteoarthritis. Delaying the time to primary THA reduces the risk of revision and re-revision, thereby avoiding further morbidity.³

A THA is often used as the primary outcome measure for long-term outcomes studies of patients undergoing a PAO. The series presented by Steppacher et al³ of 58 patients (68 hips) undergoing PAO for dysplasia, followed up to 20 years, found that 60% of hips were preserved, but 38% had been converted to THA. At 30 years, 29% of hips were preserved, but over 70% went on to develop osteoarthritis, pain, or undergo a THA.⁴

A retrospective analysis by Holleyman et al,⁵ of 844 patients on the Non-Arthroplasty Hip Registry (NAHR) who underwent a PAO, addressed a deficit in the literature of patient-reported outcome measures (PROMs) following a PAO. They demonstrated significant improvement ($p < 0.001$) of PROMs at six, 12, and 24 months postoperatively. However, few existing studies have explored long-term PROMs, or indeed outcomes that are of importance to patients.

Boye et al's⁶ group explored key factors that motivate patients to undergo a PAO, and investigated the discrepancy between patients and surgeons regarding preoperative expectations. The most common reason for deciding to undergo a PAO given by patients was pain, followed by wanting to improve their walking ability, ability to perform daily activities, and improve recreational performance.

Mahomed et al⁷ developed a validated short self-reported questionnaire to evaluate patient satisfaction with their hip and knee arthroplasty surgery. The four items on the questionnaire were satisfaction with the extent of pain relief, improvement in the ability to perform housework, performing recreational activities, and overall satisfaction with joint replacement. These metrics mirror the work done by Boye et al.⁶ We sought to determine whether the patient satisfaction questionnaire validated by Mahomed et al⁷ could be applied to patients undergoing a PAO.

We present the long-term follow-up of a large consecutive series of patients who have undergone PAO surgery. While we have included postoperative outcomes such as radiological correction, PROMs, and complications, the primary outcome measure we report is the patient satisfaction scores, for which we have also tested its internal consistency (reliability) and convergent validity for use in this cohort.

Methods

We included all patients who had undergone a PAO via an ilioinguinal approach by our senior author (MFG) from July 1998 to February 2013. Our research and development department determined this study was an evaluation of service. The online Health Research Authority decisions tool also found that ethical approval was not required.⁸

Surveys were sent to patients via post or email according to their preference. Descriptive demographic data, including age at the time of surgery, sex, side of surgery, and age at the time of follow-up, were recorded for patients who had completed the survey and who had pre- and postoperative radiographs.

Patients were asked to rate the level of satisfaction with their PAO in achieving pain relief, ability to restore activities of

daily living, including ability to return to housework, ability to perform recreational activities, and overall patient satisfaction. Items were scored on a four-point Likert scale with response categories consisting of very satisfied (100 points), somewhat satisfied (75 points), somewhat dissatisfied (50 points), and very dissatisfied (25 points).⁷

PROMs including the Western Ontario and McMaster Universities Arthritis Index (WOMAC),⁹ University of California, Los Angeles (UCLA) activity score,¹⁰ and EuroQol-five dimension questionnaire (EQ-5D)¹¹ were also collected as part of the questionnaire. Complications were categorized according to the Clavien-Dindo grade.¹² Conversion to THR was also noted.

In the case of bilateral PAOs, patients were asked to complete a separate survey for each side. To exclude COVID-19 infection as a potential confounder, completed surveys were only included if returned prior to 1 June 2019.

Retrospective preoperative radiological evaluation was performed by an orthopaedic surgeon (JRB) trained in young adult hip radiography to confirm preoperative diagnosis of hip dysplasia, as well as pre- and postoperative measurements of lateral centre-edge angle (LCEA), Tönnis angle and integrity of Shentons arc were measured on anteroposterior (AP) pelvic radiographs. The anterior centre-edge angle (ACEA) was measured on a false profile radiograph.

Statistical analysis

To measure reliability of the patient satisfaction scale, the distribution of scale scores was examined for skewness and kurtosis. Floor and ceiling effects were calculated using the percentage of scoring at the lowest and highest scale levels. The internal consistency (reliability) of the patient satisfaction scale was measured using the Cronbach's α coefficient. This tests how well a set of variables correlate with each other and with the aggregate scale score. The Cronbach's α therefore measures the capacity of the scale to measure a unidimensional scale such as patient satisfaction. A value of 0.7 or greater is considered acceptable, greater than 0.8 is considered good, and greater than 0.9 is considered excellent.⁷

To test convergent validity, the results of the patient satisfaction scale were compared against the absolute total WOMAC, UCLA, and EQ-5D scores. A Spearman's rank correlation coefficient was used, as not all data were normally distributed. All statistical analyses were completed using SPSS version 27 (IBM, USA).

With the power set at 0.8, we determined a minimum sample size of 64 patients to detect a statistically significant and clinically important difference in radiological outcomes. The range and mean values of pre- and postoperative correction were calculated and a paired t -test for continuous variables was used to determine whether the radiological correction achieved was statistically significant. A p -value of 0.05 was used to define significance.

Results

A total of 143 PAOs were performed via an ilioinguinal approach for hip dysplasia by our senior author (MFG) between 1998 and 2013. Of those, 90 postoperative surveys were returned. Only 65 patients (73 hips) had both pre- and postoperative radiographs available for measurement (Figure 1). The mean time to follow-up was 15 years (6.5 to 20). The

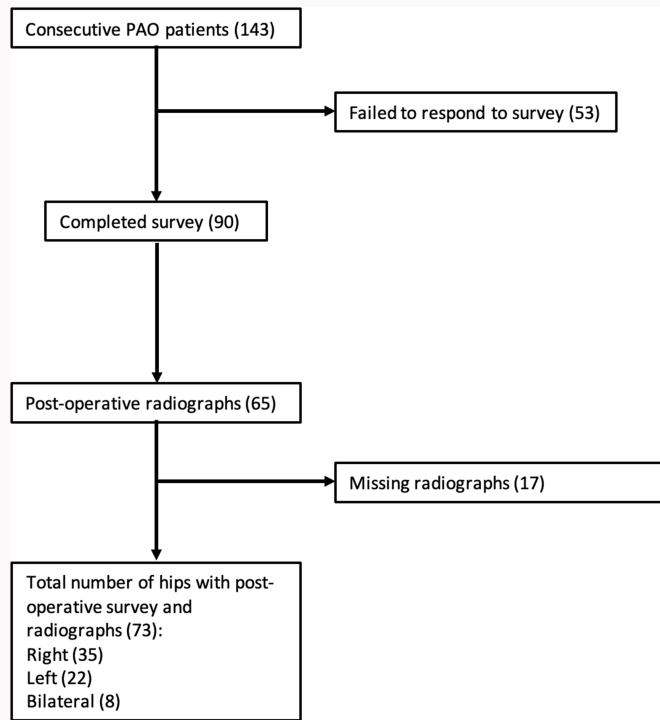


Fig. 1

A STROBE flow diagram detailing the number of periacetabular osteotomies (PAOs) performed, the number of surveys returned and the number of hips with completed surveys and pre- and postoperative radiographs.

Table 1. Postoperative patient satisfaction scores. Cronbach's α coefficients for internal consistency (reliability) of the satisfaction scale is included at the bottom of the table.

Satisfaction	Pain relief (%)	Improve ability to perform daily activities (%)	Improve ability to perform recreational activities (%)	Overall satisfaction (%)
Very satisfied	66.7	68.9	65.6	68.9
Somewhat satisfied	25.6	23.3	25.6	22.2
Somewhat dissatisfied	3.3	4.4	4.4	4.4
Very dissatisfied	4.4	3.3	4.4	4.4
Cronbach's α coefficient	0.93	0.91	0.89	0.94

majority of patients were female 66 (91%), with a mean age of 26.4 years at the time of their surgery (14.9 to 48.3).

Patient satisfaction

At the time of follow-up, 49 of patients (66.7%) were very satisfied with the pain relief offered by their PAO, 50 (68.9%) were very satisfied with their ability to get back to housework, and 48 (65.6%) were satisfied in their improved recreational ability. Overall, 50 (68.9%) were very satisfied with their surgery. The internal consistency (reliability) of the patient satisfaction questionnaire, measured using Cronbach's α , ranged from 0.89 to 0.94 (Table 1).

The postoperative PROMs are detailed in Table 2. The Spearman's correlation coefficient for convergent validity with the overall patient satisfaction scores is also included. It shows a strong correlation with WOMAC scores (0.61, $p < 0.001$), but a weak correlation with UCLA activity (-0.38, $p < 0.001$) and EQ-5D scores (-0.58, $p < 0.001$).

Radiological outcomes

The radiological measures of dysplasia improved postoperatively in all four parameters. This is demonstrated in Table 3 and Table 4.

Complications

Seven patients (9.6%) suffered a complication of any kind. Complications were categorized according to the Clavien-Dindo classification system for surgical complications (Table 5). The majority of complications were superficial wound infections treated with oral antibiotics. One patient suffered a pressure ulcer on the heel of their foot which required district nurse dressings, one patient needed a revision of their PAO, and one patient suffered damage to their femoral artery, requiring an amputation.

Only two patients (2.7%) had subsequently undergone a THA at the time of follow-up. One patient had their THA six years after their PAO, the other 13 years after their PAO.

Table II. Postoperative patient-reported outcome measures.

PROM	Mean (SD)	Mean (95% CI)	Spearman's correlation with overall patient satisfaction
WOMAC	44 (19.8)	44 (39.85 to 48.15)	0.61 (p < 0.001)
UCLA activity	5.9 (2.1)	5.9 (5.46 to 6.34)	0.38 (p < 0.001)
EQ-5D	0.819 (0.14)	0.819 (0.79 to 0.85)	0.58 (p < 0.001)

CI, confidence interval; EQ-5D, EuroQoL five-dimension questionnaire; PROM, patient-reported outcome measure; SD, standard deviation; UCLA, University of California, Los Angeles activity score; WOMAC, Western Ontario and McMaster Universities Arthritis Index.

Table III. The mean and range of values of anterior centre edge angle, lateral centre-edge angle, Tönnis angle, and whether Shenton's arc is intact.

Variable	Preoperative	Postoperative
Mean anterior centre edge angle, ° (range)	5.52 (-12 to 20)	32.2 (14 to 51)
Mean lateral centre edge angle, ° (range)	3.39 (-18 to 15)	28.16 (-11 to 56)
Mean Tönnis angle, ° (range)	25.47 (8 to 50)	7.78 (-5 to 38)
Shenton's arc intact, n		
No	56	22
Yes	44	78

The p-values between groups were all < 0.001 (paired t-test).

Discussion

Acetabular dysplasia is known to contribute to the pathophysiology of hip osteoarthritis. A PAO is a surgical option for symptomatic acetabular dysplasia in the young adult population. The aims of treatment are to alleviate symptoms, in particular hip pain, and to delay the progression of osteoarthritis.⁶

The majority of outcome measures reported in the literature focus on radiological correction and clinical factors from PROMs. In our single consecutive cohort of 73 hips, a statistically significant improvement in all postoperative radiological parameters, including ACE, LCE, and Tönnis angle, was achieved.

Few studies also explore the outcomes of interest to patients themselves. Boye et al⁶ recently explored the mismatch between patient and surgeon expectations following a PAO; patients were generally more optimistic than their surgeons about the degree of symptomatic and functional improvement one might expect from surgery.

Several key domains were identified by patients as important outcomes following PAO surgery. These include pain relief, ability to perform daily activities, and improvement in the ability to perform recreational activities. Pain relief was found to be the main motivating factor for patients undergoing a PAO, and was the only domain in which patient expectations of surgery matched that of their surgeon. Surgeons had lower expectations for improved walking ability and return to sport, particularly in patients with higher baseline levels of activity. The study concluded that exploring postoperative satisfaction with pain relief, and improved

Table IV. Pre- and postoperative Tönnis grades for osteoarthritis.

Tönnis grade, n (%)	Preoperative	Postoperative
0	11 (14)	0
1	58 (72)	64 (80)
2	11 (14)	15 (19)
3	0	1 (1)

Table V. Postoperative complications categorized as per the Clavien-Dindo classification system.

Clavien-Dindo grade	Number of patients
I - A complication that requires no treatment and has no clinical relevance, does not deviate from normal postoperative course	1
II - A deviation from normal postoperative course such as unplanned clinic visit or outpatient treatment	4
III - A complication that is treatable but requires surgical intervention or unplanned surgical admission	1
IV - A complication that is life-threatening, requires ICU admission, or will result in permanent disability	1
V - Death	0
Total	7

ICU, intensive care unit.

recreational function, is an important next step to help better inform patients and their surgeons regarding the likelihood of a successful outcome following surgery.⁶

The short self-reported questionnaire, developed and validated by Mahomed et al⁷ to evaluate patient satisfaction following hip and knee arthroplasty surgery, includes four key items, which we used for our cohort of patients who had undergone a PAO. At a mean time of follow-up of 15 years, a total of 92.3% of patients remained satisfied with their PAO in providing pain relief, improving their ability to perform daily activities and their ability to perform athletic activities. We found this questionnaire to be a reliable (high internal consistency) and valid instrument for measuring long-term satisfaction following a PAO.

The distribution of responses for each item demonstrated that patients were more satisfied with improvement in pain than function. This is consistent with Boye et al's⁶ findings, in which pain relief was the main motivating factor for patients undergoing a PAO. We found a better correlation between the satisfaction scores and WOMAC scores than with the UCLA activity score and EQ-5D. This suggests that while patient satisfaction is related to improvement in pain and function, these domains are not directly correlated. Therefore, the satisfaction scale measures a different but interrelated domain.

A Danish study of 316 patients (401 hips) who underwent a PAO with a comparable length of follow-up to our study (mean 12.4 years) found a median WOMAC score of 74.8.¹³ While it is encouraging to find that our study, at a mean follow-up of 15 years, found a lower WOMAC score of 44 (standard deviation (SD) 19.8), we accept that a limitation of our study is the high drop-out rate of 37%. This opens the study to non-response bias, and so we may not have the true value of PROMs for our cohort.

The study conducted by Holleyman et al,⁵ investigating the PROMs post-PAO surgery, reports significant improvement ($p < 0.001$) in EQ-5D index at six, 12, and 24 months (+0.172, +0.187, and +0.166, respectively). We report a mean EQ-5D of +0.819 (0.57 to 1), indicating maintenance of high quality of life in patients who underwent a PAO at a similar age, but at a longer time interval to follow-up.

Okoroafor et al¹⁴ published their mid-term follow-up series of 70 patients (79 hips) with a mean follow-up of 6.8 years (5 to 11). They reported a mean UCLA activity score of 7.9 (SD 2.2), indicating maintenance of a high level of activity. While we report a lower level of activity by comparison (mean score of 5.9 (SD 2.1)), our study has a longer mean time to follow-up.

A review of 40 studies including 4,070 hips undergoing a PAO by Ali and Malviya¹⁵ reported an overall complication rate of 7%, but a higher rate of complications with an ilioinguinal approach. We report a complication rate of 9.6%, which is marginally higher than the overall complication rate reported by Ali and Malviya,¹⁵ but which may be explained by the fact that a ilioinguinal approach was used by our senior surgeon. Ali and Malviya¹⁵ also reported that 4.27% of hips were converted to a THA at a mean follow-up of 52.8 months (12 to 132). In our series, only 2.7% of patients had undergone a subsequent THA at a mean follow-up of 114 months (72 to 156), however the low rate of conversion to THA in our study may be due to a lower response rate to our questionnaire.

Limitations of our study are that the total number of patients included was small, although there were enough patients to ensure it was adequately powered. An important limitation of our study is the low clinical and radiological follow-up, below the accepted drop-out rate of 20%. While the drop-out rate seen in this study threatens its validity, every effort was made to contact patients who did not respond to the questionnaire. The reality of conducting a long-term study such as this is that there is a greater chance of non-responders.

A further limitation of our study is that we did not record preoperative PROMs and therefore were unable to provide a δ value at the point of long-term follow-up. While PROMs were arguably not as commonly used in 1998 as they are today, the inability to provide a δ value is regrettable. However, the primary outcome of interest of this study was the

patient satisfaction questionnaire, which we have validated for use in a PAO cohort. The PROM scores were a secondary outcome measure, with the WOMAC score having a stronger correlation with the satisfaction questionnaire.

Understanding the outcomes of importance to our patients is key to informing the consent process in modern surgical practice. This study demonstrates that long-term rates of patient satisfaction of PAO surgery remain high in key domains of importance to our patients, and validates the use of these questions in further PAO outcome studies.

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Data sharing

The datasets generated and analyzed in the current study are not publicly available due to data protection regulations. Access to data is limited to the researchers who have obtained permission for data processing. Further inquiries can be made to the corresponding author.

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Ethical review statement

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