*Journal of Hip Preservation Surgery* Vol. 7, No. 1, pp. 130–139
doi: 10.1093/jhps/hnz066
Advance Access Publication 14 January 2020
Research article

# Does pain and hip function improve 2 years after reverse periacetabular osteotomy? A follow-up study of 74 patients

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Submitted 16 August 2019; revised version accepted 18 December 2019

## ABSTRACT

Data on outcome in patients with acetabular retroversion (AR) treated with reverse periacetabular osteotomy (reverse PAO) are sparse. The aim of the study was to investigate changes in pain and hip function among patients with AR 2 years after reverse PAO and to examine whether changes in pain were associated with changes in hip function. In addition, to evaluate patient satisfaction and changes in quality of life (QoL). We present a prospective follow-up study with patient-reported outcome data from Aarhus University Hospital in Denmark. Pain at rest and during activity was measured with a Visual Analogue Scale (VAS), hip function with the Hip disability and Osteoarthritis Outcome Score (HOOS) and QoL with the Short-Form 36, pre-operatively and 2 years after reverse PAO in 74 patients. Changes were analysed using paired *t*-test and multiple linear regressions. Significant and clinically relevant mean improvements in pain and hip function were found. The numbers of responders achieving a minimal clinically important difference varied from 51 to 73%. Positive significant association between changes in pain and changes in hip function were found. Significant mean improvement in QoL was found. The study had a loss to follow-up of 23%. Two years after reverse PAO, patients diagnosed with AR showed significant and clinically relevant mean improvements in pain and hip function. Decreased pain was significantly associated with improved hip function. The majority of patients were satisfied with the result of surgery and QoL was similar to the Danish background population.

## INTRODUCTION

The diagnoses of hip dysplasia and femoroacetabular impingement are the non-degenerative cause of symptoms in young patients. Acetabular retroversion (AR) has been described as a subtype of femoroacetabular impingement pincer deformity with a low posterior sector angle [1–6]. AR presents with a retroverted acetabulum in the sagittal plan [2, 4, 7]. The AR mal-orientation leads to poor posterior coverage of the femoral head and an excessive anterior marginal prominence [8]. This condition may result in labral tear and cartilage damage [9–12]. AR appears as an isolated entity or in a combination with hip dysplasia. Unrecognized AR may cause problems in the treatment of hip dysplasia and femoroacetabular impingement [2, 7, 8, 11, 13, 14].

Patients typically aged between 15 and 35 years describe insidious symptoms with no prior trauma. The symptoms include activity-related groin pain and pain related to a sitting position that may increase when rising to standing position. Clinically, the most frequent finding is positive anterior hip impingement [1, 2]. Radiographically, AR can be described by a positive crossover, a posterior wall, and

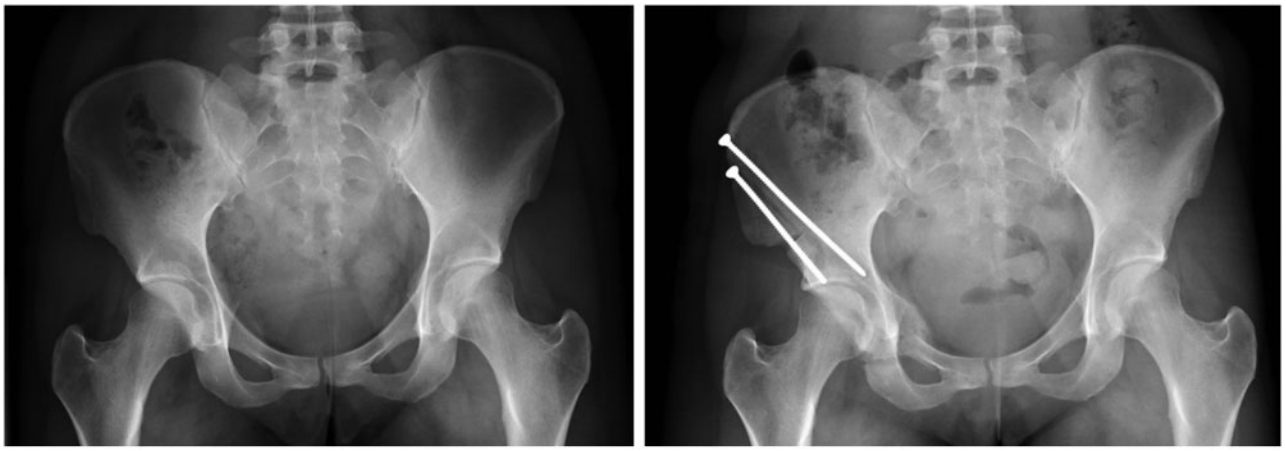

**Fig. 1.** Pre- and post-operative X-rays of one of the operated patients. Note that on the pre-operative X-ray of the right hip there is crossover, posterior wall sign and ischial spine sign. On the post-operative X-ray of the same hip, there is no longer crossover and posterior wall sign.

ischial spine sign [4, 15–18]. If untreated, AR may lead to secondary osteoarthritis [4, 8–10, 12]. The choice of treatment is still controversial [2, 19].

There is increasing evidence of an externally rotated hemipelvis resulting in AR [15, 20]. AR can be treated surgically with a reverse periacetabular osteotomy (reverse PAO) [1, 11, 14, 21] (Fig. 1).

The clinical aim of reverse PAO is to decrease symptoms related to hip pain and function as well as prevent or delay the development of osteoarthritis. Results of AR treated with reverse PAO are sparse. So far, only 71 hips with AR treated with reverse PAO have been reported in the literature [4, 14, 21]. Use of patient-reported outcomes with clinical interpretation has been suggested to give more precise results [22–25].

The aim of this study was to examine changes in pain and hip function among young patients with AR 2 years after reverse PAO and to examine whether changes in pain were associated with changes in hip function. Moreover, patient satisfaction and changes in quality of life (QoL) were assessed.

## MATERIALS AND METHODS

### Study design and setting

This is a prospective follow-up study using patient-reported outcome data from an online clinical database at the Department of Orthopaedic Surgery, Aarhus University Hospital in Denmark.

### Study population and selection

The study population included patients diagnosed with AR and hip pain undergoing reverse PAO surgery between June 2012 and March 2017. Minimally invasive transsartorial surgery was performed by co-authors K.S. and S.S.J. at Aarhus University Hospital or at the private hospital Mølholm [26].

The inclusion criteria were (i) patients diagnosed with AR, (ii) undergoing reverse PAO and (iii) who had completed pre-operative- and 2-year follow-up questionnaires.

The exclusion criteria were (i) age $>$ 50 years, (ii) BMI $>$ 30, (iii) Tönnis' degree of osteoarthritis $>$1 and finally (iv) the last operated hip, if reverse PAO was performed on both hips during the study period.

A total of 143 patients were operated during the 4.5 years of inclusion. Fourteen patients living outside Denmark and not speaking Danish were present in the database, but no patient-reported data were collected since questionnaires were only in Danish. A total of 7 patients had bilateral operations and contributed with data on only one hip; 26 patients did not complete the baseline questionnaire and 22 patients were lost to follow. Thus, 74 patients were included in the final study (Fig. 2).

### Data collection

Patients were invited to a pre-operative meeting at the hospital where they were encouraged to complete the baseline questionnaire on paper or online. Data were collected on age, gender, height, weight, pain using a visual analogue scale (VAS), Hip disability and Osteoarthritis Outcome Score (HOOS) and QoL using the Short-Form 36 (SF-36).

At the day of surgery, the surgeon completed a questionnaire about the type of surgery, diagnosis, clinical data and following radiological parameters, Wiberg's

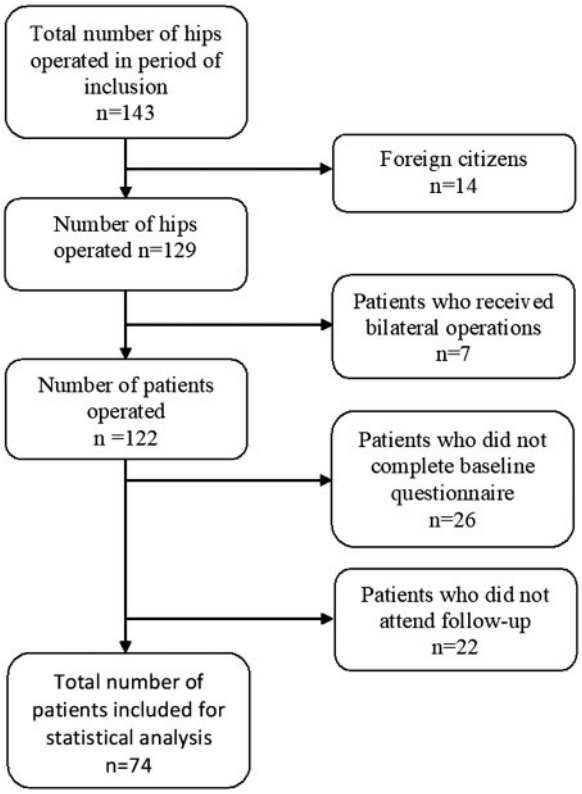


**Fig. 2.** Flowchart illustrating inclusion and exclusion of patients.

centre-edge angle, acetabular index angle, posterior wall sign, ischial spine sign, crossover sign and degree of osteoarthritis according to Tönnis' classification.

At 2-year follow-up, a questionnaire was distributed to the patients either online or by mail. The questionnaire was identical to the baseline questionnaire except for questions about patient satisfaction. If the patients did not respond, two reminders were sent out after 1 month and telephone contact was attempted.

## Outcome measures

### *Changes in pain*

Changes in pain at rest and during activity were measured with a VAS. VAS is easy to use and is measured on a 100-mm horizontal line; a higher score indicates higher pain intensity [27]. Minimal clinically important difference (MCID), according to pain improvement during movement has been reported to be 15.3 mm for patients with hip osteoarthritis [28].

### *Changes in hip function*

Changes in hip function were measured using the patient-reported and hip specific questionnaire HOOS, which is


**Fig. 3.** Mean scores for QoL at baseline and at 2-year follow-up within the eight health domains of SF-36 for the included 74 patients. The Danish background population and maximum QoL is presented.

valid and reliable in patients with osteoarthritis and patients undergoing hip arthroscopic surgery [22, 29]. HOOS consists of 40 questions divided into five subscales: activities of daily living (ADL), QoL, symptoms, pain and sport/recreation. HOOS is measured on a scale from 0 to 100, were 100 represents no symptoms. The HOOS subscales ADL, sport/recreation and symptoms were used to measure hip function. MCID has been reported to be between 6 and 11 for patients undergoing total hip replacement or hip arthroscopic surgery, respectively [22, 30]. These MCID scores have also been referred to in a study on patients treated with PAO [31].

*Changes in QoL.* Changes in QoL were measured using the SF-36, a generic health assessment tool. SF-36 is valid and reliable to measure both mentally and physically health-related QoL [32]. SF-36 consists of 36 questions within eight health domains. The score ranges from 0 to 100 where 100 is the best possible. Reference values for the Danish population are available and presented in Fig. 3.

### *Patient satisfaction*

Patient satisfaction was measured at follow-up after 2 years with three patient-reported questions.

i. When you think of your daily life, your pain, your symptoms, disability and QoL, do you

regard your current situation to be satisfactory? Yes/No

ii. On a scale from 0 to 10, where 10 is the best, how satisfied are you overall with the progress and result of your hip surgery so far?

iii. If you had known your progress and result of the surgery before you were operated, would you still undergo surgery?

### Statistical analysis

All statistical analyses were made using STATA 15.1. The significance level for all hypotheses was 5%.

Mean changes in pain, hip function and QoL were calculated, and a positive change indicated an improvement presented as mean and 95% CI. Statistical significance was tested using the paired *t*-test.

Numbers and percentages of responders of reverse PAO were calculated according to MCID for the variables VAS and HOOS. Floor or ceiling effects were considered to be present if >15% of patients scored the lowest or highest point on the five HOOS subscales.

The association between 'changes in pain' and 'changes in hip function' was evaluated using multiple linear regressions and adjusted for potential confounding by age and gender [31, 33].

Tests for effect modification were performed. All assumptions were met, and normality was checked using QQ plots, scatter plots and dot plots. A drop-out analysis was performed using the unpaired *t*-test.

## RESULTS

### Baseline characteristics

Baseline characteristics of the 74 patients included for analysis are presented in Table I. At 2-year follow-up, ceiling effects were present in three subscales: HOOS ADL (27%), HOOS sport/recreation (22%) and HOOS pain (16%). Eight patients had additional surgery with symptomatic screw-removal. No hips underwent conversion to total hip arthroplasty.

### Change in pain, hip function and QoL

The mean changes in pain and hip function from baseline to follow-up at 2 years improved significantly and were considered clinically relevant according to MCID. The proportion of responders, who achieved selected MCID values varied from 51 to 73% (Table II). The magnitude of changes for all outcome measures was presented with a high effect size (<0.8) except for the mental component score presented with low to medium effect sizes. The mean changes in QoL improved significantly (Table II) although not reaching the level in the Danish background population (Fig. 3).

### Associations

Statistically significant associations were found between changes in pain at rest measured with VAS and hip function measured with HOOS ADL ($\beta = 0.50$), symptoms ($\beta = 0.52$) and sport/recreation ($\beta = 0.59$). Likewise, significant associations were found between changes in pain during activity measured with VAS and hip function measured with HOOS ADL ($\beta = 0.43$), symptoms ($\beta = 0.50$) and sport/recreation ($\beta = 0.63$; Table III). The estimates for the adjusted $\beta$-coefficients indicate the hip function based on changes in pain including potential confounders. Hip function measured with HOOS ADL increase 4.3 points with a 10 mm decreased VAS pain. The variation of changes in pain at rest explains between 37 and 45% of the variation of hip function measured with HOOS sport/recreation, HOOS symptoms and HOOS ADL. The variation of changes in pain during activity explains between 42 and 52% of the variation of hip function.

### Patient satisfaction

A total of 45 (61%) patients considered their current situation to be satisfactory in relation to pain, symptoms, disability and QoL. Sixty (81%) patients would undergo surgery again if they had known their progress and result of the surgery. On a scale from 0 to 10, where 10 was the best, patients reported an overall satisfaction with progress and result of the surgery with a median value of 8 (IQR: 6–10).

### Drop-out analysis

A total of 22 of the 96 patients diagnosed with AR undergoing reverse PAO surgery did not complete the follow-up questionnaire at 2 years, corresponding to a drop-out rate of 23%. The patients lost to follow-up did not differ significantly from the participants. Among the drop-outs, the number of men was higher, pain at baseline was reported higher, and hip function lower, although not significantly (Table IV).

## DISCUSSION

The aim of this study was to examine changes in pain and hip function among patients diagnosed with AR 2 years after reverse PAO. Furthermore, to investigate the association between changes in pain and hip function. In addition, patient satisfaction and changes in QoL were evaluated. The study showed significant and clinically relevant mean changes in hip function and in pain at rest and during activity. A positive dose–response relationship was

**Table I. Demographic data, patient-reported outcomes, clinical test and radiographical data at pre- and post-operative levels**

| *Variable* | *Pre-operative* | *Post-operative* |
|---|---|---|
| Demographic data ($n = 74$) | | |
| Age, median (IQR) | 23 (18–31) | — |
| Female, *n* (%) | 49 (66) | — |
| Male, *n* (%) | 25 (34) | — |
| BMI, mean (SD) | 22.4 (2.6) | — |
| Bilateral surgery, *n* (%) | 7 (9) | — |
| PRO data ($n = 74$) | | |
| VAS, median (IQR)[a] | | |
| Rest | 29 (14–50) | — |
| Activity | 70 (61–82) | — |
| HOOS, mean (SD)[b] | | |
| Pain | 57.7 (19.5) | — |
| Symptoms | 54.1 (17.6) | — |
| ADL | 67.6 (20.3) | — |
| Sport/recreation | 48.1 (22.6) | — |
| QoL | 34.5 (16.1) | — |
| SF-36, mean (SD)[b] | | |
| Physical component summary score | 36.5 (7.2) | — |
| MCS score | 49.3 (12.8) | — |
| Clinical test ($n = 61$) | | |
| Positive impingement, *n* (%) | 60 (98) | — |
| Radiographical data | ($n = 68$) | ($n = 53$) |
| CE angle, mean (SD) | 25.9 (6.8) | 34.4 (5.7) |
| AI angle, mean (SD) | 8.4 (5.5) | 1.0 (4.5) |
| Tönnis degree of osteoarthritis, median (IQR) | 0 (0–0) | 0 (0–0) |
| Cross over sign, *n* (%) | 59 (87) | 10 (19) |
| Posterior wall sign, *n* (%) | 57 (84) | 17 (32) |
| | ($n = 53$) | ($n = 53$) |
| Ischial spine sign, *n* (%) | 23 (43) | 13 (25) |

n, number; IQR, interquartile range; SD, standard deviation; BMI, body mass index; PRO, patient-reported outcome; VAS, Visual Analogue Scale, HOOS, Hip disability and Osteoarthritis Outcome Score; ADL, activities of daily living; SF-36, Short-Form 36; CE, center edge; AI, acetabular index.

[a]Scale from 0 to 100 points, where 100 points indicate worst possible outcome.

[b]Scale from 0 to 100 points, where 100 points indicate best possible outcome.

**Table II. Mean changes from baseline to follow-up at 2 years for pain, hip function and QoL MCIDs are presented. The group of responders reaching MCID is presented with numbers and percentages**

| *Outcomes* (n = 74) | *Baseline, mean (SD)* | *Follow-up, mean (SD)* | *Changes, mean (95% CI)* | *MCID* | *MCID responders* n *(%)* | *Effect size Cohen's* d |
|---|---|---|---|---|---|---|
| VAS[a] | | | | | | |
| Rest | 32.8 (23.3) | 14.0 (20.1) | 18.8 (11.9; 25.6) | 15 | 38 (51.3) | 0.9 |
| Activity | 69.0 (18.6) | 34.5 (27.0) | 34.5 (27.0; 41.9) | 15 | 54 (73.0) | 1.5 |
| HOOS[b] | | | | | | |
| Pain | 57.7 (19.5) | 81.1 (19.4) | 23.3 (18.0; 28.6) | 9 | 54 (73.0) | 1.2 |
| Symptoms | 54.1 (17.6) | 72.9 (19.5) | 18.9 (13.6; 24.1) | 9 | 52 (70.3) | 1.0 |
| ADL | 67.6 (20.3) | 86.7 (16.5) | 19.1 (14.1; 24.1) | 6 | 51 (68.9) | 1.0 |
| Sport/recreation | 48.1 (22.6) | 71.9 (26.4) | 23.8 (17.5; 30.2) | 10 | 49 (66.2) | 1.0 |
| QoL | 34.5 (16.1) | 62.0 (24.0) | 27.4 (21.8; 33.1) | 11 | 53 (71.6) | 1.3 |
| SF-36[b] | | | | | | |
| PCS | 36.5 (7.2) | 46.7 (10.4) | 10.1 (7.7; 12.6) | — | — | 1.1 |
| MCS | 49, 3 (12.8) | 52.2 (11.1) | 2.9 (0.4; 5.4) | — | — | 0.3 |

n, numbers; SD, standard deviation; CI, confidence interval; VAS, Visual Analogue Scale; HOOS, Hip disability and Osteoarthritis Outcome Score; ADL, activity of daily living; SF-36, Short-Form 36; PCS, physical component summary score; MCS, mental component summary score.
[a]Scale from 0 to 100 points, where 100 points indicates worst possible outcome.
[b]Scale from 0 to 100 points, where 100 points indicates best possible outcome.

**Table III. Unadjusted and adjusted estimates for $\beta$-coefficients from the linear analysis for the associations between changes in pain measured with VAS at rest and during activity and changes in hip function measured with HOOS from baseline to 2-year follow-up**

| | *Unadjusted β-coefficients (95% CI)* | P-*value* | *Adj.* $R^2$ | *Adjusted β-coefficients (95% CI)* | P-*value* | *Adj.* $R^2$ |
|---|---|---|---|---|---|---|
| Δ HOOS | | | | | | |
| Δ Symptoms | | | | | | |
| ΔVAS rest | $\beta = 0.50$ (0.37; 0.64) | <0.05 | 0.42 | $\beta = 0.52$ (0.38; 0.66)[a] | <0.05 | 0.43 |
| ΔVAS activity | $\beta = 0.50$ (0.38; 0.61) | <0.05 | 0.49 | $\beta = 0.50$ (0.38; 0.61)[a] | <0.05 | 0.50 |
| Δ ADL | | | | | | |
| ΔVAS rest | $\beta = 0.49$ (0.36; 0.62) | <0.05 | 0.45 | $\beta = 0.50$ (0.37; 0.63)[a] | <0.05 | 0.45 |
| ΔVAS activity | $\beta = 0.43$ (0.31; 0.55) | <0.05 | 0.41 | $\beta = 0.43$ (0.31; 0.55)[a] | <0.05 | 0.42 |
| Δ Sport/recreation | | | | | | |
| ΔVAS rest | $\beta = 0.56$ (0.39; 0.74) | <0.05 | 0.36 | $\beta = 0.59$ (0.42; 0.77)[a] | <0.05 | 0.37 |
| ΔVAS activity | $\beta = 0.62$ (0.49; 0.76) | <0.05 | 0.53 | $\beta = 0.63$ (0.49; 0.77)[a] | <0.05 | 0.52 |

Adj. $R^2$, adjusted *R*-squared; HOOS, Hip disability and Osteoarthritis Outcome Score; VAS, Visual Analogue Scale; ADL, activity of daily living.
[a]Adjusted for age and gender.

**Table IV. Drop-out analysis comparing baseline characteristics for participants and patients lost to follow-up at 2 years follow-up**

| *Variable* | *Lost to follow-up* (n = 22) | *Participants* (n = 74) | P-*value* |
|---|---|---|---|
| Demographic data | | | |
| Age, median IQR | 24 (20–27) | 23 (18–31) | 0.63[a] |
| Female, *n* (%) | 13 (59) | 49 (66) | 0.38[b] |
| Male, *n* (%) | 9 (41) | 25 (34) | |
| BMI, mean (SD) | 21.9 (3.0) | 22.4 (2.6) | 0.62[c] |
| Bilateral surgery, *n* (%) | 0 (0) | 7 (9) | 0.13[b] |
| PRO data | (*n* = 22) | (*n* = 74) | |
| VAS[d] | | | |
| Rest, median (IQR) | 34 (17–64) | 29 (14–50) | 0.44[a] |
| Activity, median (IQR) | 76 (63–88) | 70 (61–82) | 0.40[a] |
| HOOS, mean (SD)[e] | | | |
| Pain | 49.2 (19.9) | 57.7 (19.5) | 0.08[c] |
| Symptoms | 48.9 (25.5) | 54.1 (17.6) | 0.28[c] |
| ADL | 58.4 (25.6) | 67.6 (20.3) | 0.08[c] |
| Sport/recreation | 42.1 (28.2) | 48.1 (22.6) | 0.30[c] |
| QoL | 33.8 (16.7) | 34.5 (16.1) | 0.85[c] |
| SF-36, mean (SD)[e] | | | |
| PCS | 35.9 (10.7) | 36.5 (7.2) | 0.90[c] |
| MCS | 46.0 (12.3) | 49.3 (12.8) | 0.28[c] |
| Clinical test | (*n* = 14) | (*n* = 61) | |
| Positive impingement, *n* (%) | 13 (93) | 60 (98) | 0.25[b] |
| Radiographical data | (*n* = 19) | (*n* = 68) | |
| CE angle, mean degrees (SD) | 26.3 (4.1) | 25.9 (6.8) | 0.81[c] |
| AI angle, mean degrees (SD) | 6.4 (4.9) | 8.4 (5.5) | 0.17[c] |
| Tönnis degree of osteoarthritis, median (IQR) | 0 (0-0) | 0 (0-0) | 0.45[a] |
| Cross over sign, *n* (%) | 17 (89) | 59 (87) | 0.75[b] |
| Posterior wall sign, *n* (%) | 16 (84) | 57 (84) | 0.97[b] |
| | (*n* = 14) | (*n* = 53) | |
| Ischial spine sign, *n* (%) | 5 (36) | 23 (43) | 0.79[b] |

*n*, number; IQR, interquartile range; SD, standard deviation; BMI, body mass index; PRO, patient-reported outcome; VAS, Visual Analogue Scale, HOOS, Hip disability and Osteoarthritis Outcome Score; ADL, activities of daily living; SF-36, Short-Form 36; PCS, Physical component summary score; MCS, Mental component summary score; CE, centre edge; AI, acetabular index.

[a]Wilcoxon Rank Sum test.

[b]$X^2$ test.

[c]Unpaired *t*-test.

[d]Scale from 0 to 100 points, where 100 points indicates worst possible outcome.

[e]Scale from 0 to 100 points, where 100 points indicates best possible outcome.

found between changes in pain and changes in hip function from baseline to 2-year follow-up. The majority of patients were satisfied with their progress and result after surgery in relation to hip pain, function and health-related QoL.

Only three studies have reported outcome after reverse PAO [4, 14, 34] and only two of the studies presented follow-up data [14, 34]. Both Parry *et al.* (30 hips) and Siebenrock *et al.* (29 hips) reported significant improvements after reverse PAO using the Harris hip score and Merle d'Aubingé. With an average follow-up of 30 months, Siebenrock *et al.* [34] reported pain improvements in 17 hips and absence of pain in 11 hips. At 5-year of follow-up, Parry *et al.* [14] reported excellent results on average based on the Harris hip score, with improvements in pain and function for patients with isolated AR or AR combined with hip dysplasia. The significant improvements are in line with the results of this study, but the lack of similar outcome measures, limits further comparison. To improve the interpretation of changes in pain and hip function, the proportion of responders with a score similar or higher than MCID should be reported [25]. We found that the proportion of responders varied from 51% to 73% for pain and hip function, lowest in pain at rest and highest in pain during activity, HOOS pain and HOOS symptoms.

Pain is the most important reason for surgery. Our study demonstrated a mean improvement in VAS pain score of 18.8 from baseline to follow-up at 2 years at rest and a score of 34.5 during activity. These observations are consistent with Jakobsen *et al.* [35], who also found improvement in pain for patients with hip dysplasia undergoing PAO. At 6-month, Jakobsen *et al.* reported a reduction in VAS pain score of 21 at rest and a score of 29 points during activity with no further reduction after 24 months. Based on the consistent results, the expected pain reduction for patients with AR treated with reverse PAO is considered comparable to those of patients with hip dysplasia undergoing PAO.

To our knowledge, no previous studies have investigated the association between changes in pain and hip function for patient with AR after reverse PAO. Boje *et al.* [36] investigated the association among patients with hip dysplasia after PAO. Their results are not directly comparable to the results of this study, but parallels can be drawn because of the similarities between the two groups of patients. Boje *et al.* reported significant improvements in pain at rest measured with VAS and hip function measured with HOOS symptoms, HOOS ADL and HOOS sport/recreation 2 years after PAO. Their findings thus support the results of our study, which also found significant associations between reduction in pain and improvement in all three HOOS subscales. No studies investigating associations between pain during activity and hip function were identified.

Pain and reduced hip function among patients with AR may negatively affect their health-related QoL [37] and an association between reduction in pain and improved QoL has been reported [36]. We demonstrated a mean improvement in health-related QoL from baseline to 2-year follow-up. The effect size was high for all patient-reported outcomes except for the mental component summary score (MCS) showing low to moderate effect sizes. This may be explained by an MCS at baseline similar to the expected value of the Danish background population. Our study showed that patients were generally satisfied with their results 2 years after undergoing reverse PAO. These results did not differ from those reported for patients with hip dysplasia treated with PAO [31, 36].

### Strength and limitations

To our knowledge, this is the largest prospective follow-up study describing patient-reported outcomes in patients with AR after reverse PAO surgery. It is a strength of this study that the reverse PAO was performed by two experienced surgeons. In a clinical context it is considered a strength that the number of responders was calculated according to MCID and changes in QoL were presented together with mean values for the Danish background population.

All questionnaires are patient-reported and proven valid and reliable, though not validated for this specific study population. HOOS is originally designed for patients with osteoarthritis and patients undergoing hip arthroscopic surgery. Patients in this study population were younger and more physically active, which may explain ceiling effects in HOOS ADL, HOOS sport/recreation and HOOS pain. As a result, the mean improvement from baseline to follow-up may have been underestimated for the subscales of interest. A further limitation is the high dropout rate of 23% and it is uncertain if the patients lost to follow-up would have affected the estimates in our study. The patients lost to follow-up did not differ significantly from the participants, which is probably due to the low number of participants and drop-outs. Furthermore, the study is a follow-up study with no control group. Finally, our results do not show long-term outcomes, and whether achieved improvements are maintained with a longer follow-up is to be investigated in future studies.

## CONCLUSION

The study showed significant and clinically relevant mean changes in hip function and in pain at rest and during activity. Changes in pain at rest and during activity were

associated with changes in hip function measured with HOOS ADL, symptoms and sport/recreation, respectively 2 years after reverse PAO. Decreased pain was significantly associated with improved hip function. The study showed a statistically significant change in QoL, with values almost similar to the Danish background population. The majority of patients were generally satisfied with their result.

## FUNDING

This work was performed at the Department of Orthopaedic Surgery, Aarhus University Hospital, Denmark.

## CONFLICT OF INTEREST STATEMENT

None declared.

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