Efficacy of periacetabular osteotomy followed by progressive resistance training compared to progressive resistance training as non-surgical treatment in patients with hip dysplasia (PreserveHip) – statistical analysis plan

Lisa Cecilie Urup Reimer[ab], Stig Storgaard Jakobsen[a], Ulrik Dalgas[c], Troels Kjeldsen[abd], Julie Sandell Jacobsen[e], Kjeld Soballe[a], Tone Bere[f], Jan Erik Madsen[f], Lars Nordsletten[fg], May Arna Risberg[f], Inger Mechlenburg[abc] and Bo Martin Bibby[h].

Affiliation

[a]Department of Orthopedic Surgery, Aarhus University Hospital, Denmark.
[b]Department of Clinical Medicine, Aarhus University, Denmark
[c]Department of Public Health – Sport, Aarhus University, Denmark
[d]The Research unit PROgrez, Department of Physiotherapy and Occupational Therapy, Næstved-Slagelse-Ringsted Hospitals, Region Zealand, Denmark
[e]Physiotherapy & Research Centre for Health and Welfare Technology, Programme for Rehabilitation, VIA University College, Denmark
[f]Department of Orthopedic Surgery, Oslo University Hospital, Norway
[g]Faculty of Medicine, University of Oslo, Norway
[h]Department of Biostatistics, Aarhus University, Denmark

Corresponding author

Lisa Cecilie Urup Reimer
Department of Orthopedic Surgery, Aarhus University Hospital
Palle Juul-Jensens Boulevard 99, 8200 Aarhus, Denmark
E-mail: lisareimer@clin.au.dk
Telephone: +4526474080

Trial registration, version of statistical analysis plan and protocol

This trial is registered at www.ClinicalTrials.gov with the number NCT03941171 and the Statistical Analysis Plan is version 1. The protocol has been published in BMJ Open and this version is used in the SAP (1).

Signatures

Role	Name	Date	Signature
Person writing the SAP	Lisa Cecilie Urup Reimer	17.01.2022	
Senior statistician responsible	Bo Martin Bibby	17/1-2022	
Chief investigator/clinical leas	Inger Mechlenburg	17.01.2022	

INTRODUCTION

Background

Hip dysplasia (HD) is characterised by a shallow and steep acetabulum that does not cover the femoral head sufficiently (2). The periacetabular osteotomy (PAO) is the surgical treatment of choice for patients suffering from HD (3). In short, the osteotomized acetabular fragment is reoriented in an adducted, extended and rotated position, and fixated with screws (4). The aim of PAO is to relieve symptoms, improve physical function and prevent development of hip osteoarthritis. Even though PAO has been found to improve self-reported outcomes (5,6), muscle-tendon pain (6), muscle strength (7) and walking pattern (8), the patients do not reach a level equal to healthy volunteers one year after PAO (6,7). In other related hip conditions including hip osteoarthritis (9) and femoroacetabular impingement syndrome (10), non-surgical treatment is considered "first-line treatment". The role of non-surgical treatment for patients with HD is still to be investigated and the efficacy of PAO has not been investigated in a randomised controlled trial (RCT) previously.

Objectives

The primary aim of this trial is to examine the efficacy of PAO followed by 4 months of usual care followed by 8 months of Progressive Resistance Training (PRT) compared to 12 months of a PRT only, in patients with hip dysplasia eligible for PAO, in terms of patient-reported pain measured by the Copenhagen Hip and Groin Outcome Score (HAGOS). We hypothesise that PAO followed by usual care and PRT results in significantly less pain at 12 months follow-up compared to PRT only.

The key secondary aims are:

1. To investigate the mean difference from baseline to 12 months after surgery or first training session, between the two groups regarding the remaining subscales of HAGOS: patient-reported symptoms, physical function in daily living, physical function in sport and recreation, hip and/or groin-related quality of life.
2. To investigate the mean difference from baseline to 12 months after surgery or first training session in hip function, measured with the single leg hop for a distance test.
3. To investigate the difference in number of adverse and serious adverse events within the 12 months study period, between the two groups.
4. To investigate the mean difference from baseline to 12 months after surgery or first training session, between the two groups regarding the usage of painkillers (yes/no) and the type of analgesics.
5. To investigate the difference in the anchor question (a patient-reported question to evaluate to which extent the a priori hip problems have been addressed) at each assessment point, between the two groups.

STUDY METHODS

Trial design

This trial is a multicentre randomised controlled and assessor blinded trial, following the Consolidated Standards of Reporting Trials (CONSORT) guidelines (11). The statistical Analysis Plan (SAP) is reported in accordance with the Guidelines for the Content of Statistical Analysis Plans in Clinical Trials (12). Change in primary outcome will be measured from baseline to 12 months follow-up, while change in secondary outcomes will be measured from baseline to four and 12-months follow-up. In addition, five year and 10 year follow-up with questionnaires is planned. The trial has been registered at www.ClinicalTrials.gov with the number NCT03941171. The Central Denmark Region Committee on Biomedical Research Ethics (Journal No 1-10-72-234-18), the Danish Data Protection Agency (Journal No 1-16-02-120-19) and The Regional Committee for Medical and Health Research Ethics Region South-East Norway (Ref. 2018/1603) has approved the trial.

Randomisation

After baseline assessment, the patients will be randomized in a 1:1 ratio to either PAO followed by usual care and PRT (PAO-group) or PRT only (PRT-group). A computer-generated list of random numbers will be set up in the Research Electronic Data Capture (REDCap) randomize tool. The randomisation will be done separately for each recruitment site in blocks of varying sizes with half of the patients in each block receiving each treatment in a random permutation. This ensures that close to half of the patients receive each of the two treatments in each block (and exactly half if all blocks are filled). Administrators of the randomisation procedure will be blinded to block sizes and randomisation sequence at all times during the trial period. Allocation concealment will be ensured, as the randomisation will not be performed and revealed before the patient has been irreversibly included in the trial. After randomisation a secretary or project coordinator, will refer patients to surgery or to the treating physiotherapist/physiotherapy student who contacts the patient to arrange an appointment for the first exercise session.

Sample size

The minimal clinically relevant difference of the HAGOS pain subscale has been reported to be 9.7 points (28). Based on a previous pilot trial the SD of HAGOS pain in PAO patients is 16.2 points (15). Given a power of 0.80 and two-sided significance level $\alpha=0.05$, the estimated sample size of each intervention group is 44 patients. Allowing for possible crossovers and loss to follow-up, the number of included patients in each intervention group will be 48 patients. The sample size calculation has been performed on the minimal clinically relevant difference of the primary outcome (HAGOS pain) at 12 months follow-up. This has been done due to lack of knowledge on the expected improvements standard deviation within the 12-month period. The estimation is thus based on an assumption that the two groups will not have very different mean scores at baseline, due to randomisation.

Statistical interim analysis and stopping guidance

No formal interim analysis has been planned for the PreserveHip trial. The final deadline for recruitment of participants were originally set to be June 1st 2022, however due to the circumstances and lockdowns following the COVID-19, the inclusion period was prolonged to Marts 1st 2024.

Timing of final analysis

The final analysis of the primary outcome, the mean difference in pain assessed by the HAGOS subscale pain, will be performed after the last follow-up test. If a participant decides to drop out of the study, they are still encouraged to attend the follow-up test. In addition, papers on five and 10-year follow-up will be performed, when these follow-up tests have been performed.

Timing of outcome assessments

The trial consists of five tests timepoints; baseline, four month, 12 months, five years and 10 years after surgery or first exercise session. A table of the assessments and procedures has been presented in the protocol (Table 2).

STATISTICAL PRINCIPLES

Confidence intervals and P values

All confidence intervals will be two-sided and based upon 95% (9% CI). Consistent with contemporary statistical guidelines, the use of p values for secondary and other comparisons will be toned down when interpreting the results of this study (i.e. p values will be included but not in the conventional, dichotomous way) (13). For the primary aim, a significance level of 0.05 will be used, meaning that a result with a p value less than 0.05 will be considered as statistically significant.

Adherence and protocol deviations

Adherence is defined as the ability to follow the allocated treatment and will be compared between the groups as the number of supervised sessions that patients showed up for, the number of sessions were all exercises were completed and the number of self-reported training sessions during the study period. In addition good adherence has been predefined as participation in at least 70% of the supervised training sessions within the first four months of training. There are three predefined protocol deviations within the trial: a patient randomised to PRT undergoing PAO during the study period, a patient withdrawing from the trial after being randomised to PAO and a patient withdrawing from the trial after being randomised to PRT. In addition, a fourth protocol deviation has been detected after initiating the study: a patient receiving additional surgery after PAO (i.e. hip arthroscopy or removal of screws) within the study period

Analysis populations

The primary efficacy analysis will be assessment of the between-group difference in change in the HAGOS pain subscale from baseline to 12 months after initiating the treatment (primary endpoint). The primary analysis will follow the intention-to-treat principle and a mixed effects model will be used (see the section "Analysis method"). Sensitivity and exploratory analysis will be performed with the purposes to test the robustness of the results per-protocol with good compliance (defined as participation in ≥70% of the training sessions) and as-treated analysis, in which patients will be analysed based on their adherence to the randomised treatment expecting three groups: patients randomised to PAO, patients randomised to PRT without undergoing PAO in the follow-up period and patients randomised to PRT undergoing PAO in the follow-up period. The patients that cross over to PAO after being randomised to PRT, will most likely be a very heterogeneous group of patients because of differences in times of cross over, however due to the expected small sample in this group, the group will be treated as one group.

TRIAL POPULATION

Screening data

At both hospitals all patients eligible for PAO will be screened for the inclusion and exclusion criteria in the trial and invited to participate if they fulfil the criteria. The number of patients who did not meet the inclusion criteria as well as the number of patients who did not the exclusion criteria will be presented in a flow chart (see figure 1).

Eligibility

Patients who meet the inclusion and exclusion criteria presented below and are willing to participate are eligible for the PreserveHip study. The inclusion criteria are: (1) patients aged 18 to 40 years and diagnosed with hip dysplasia referred from primary care to the Department of Orthopaedic Surgery at one of the two participating Hospitals, (2) considered eligible for PAO by a surgeon, (3) radiographically verified hip dysplasia (Wiberg's centre-edge angle <25 degrees and Acetabular Index angle >10 degrees) and clinical symptoms, (4) range of motion: internal rotation >15 degrees, external rotation >15 degrees, hip flexion >110 degrees and (5) able to drive or commute to training sessions. The exclusion criteria are: (1) OA degree >1 on classification of Tönnis, (2) CE-angle <10 degrees, (3) previous pelvic surgery for hip dysplasia (affected side), (4) Legg–Calvé–Perthes or epiphysiolysis, (5) simultaneous bilateral PAO, (6) previous surgery for herniated disc, spondylodesis, arthroplasty of hip, knee or ankle, (7) previous surgery of the hip (tenotomy of iliopsoas tendon, z-plastic of the iliotibial tract or hip arthroscopy) in index leg, (8) neurological or rheumatoid diseases that affect the hip function, (9) inadequacy in written and spoken Danish or Norwegian and (10) Body Mass Index (BMI) >25.

Recruitment

The number of patients screened for the PreserveHip trial, as well as the number of patients not meeting the inclusion and exclusion criteria will be presented in a flow chart (see figure 1). For patients fulfilling the

inclusion criteria but not the exclusion criteria the precise number for each exclusion criteria will be presented. In addition, the number of patients allocated to PAO and PRT will be presented, with a note of how many patients received the allocated intervention and the number of patients who decided to leave the study based on allocation. For the two follow-up assessments the number of patients lost to follow-up and number of patients who discontinued the intervention will be presented. The last part of the flow chart will be the presentation of the number of participants who will be analysed.

Withdrawal

Throughout the trial period the participants are always allowed to withdraw from the study. Participants who decide to withdraw will be encouraged to complete the follow-up assessments as if they had received the intervention. Withdrawal will thus be divided in to two: withdrawal from intervention with completion of assessments and withdrawal from intervention with no further assessments. The number of participants who decide to withdraw, as well as the timing of the withdrawal, will be presented in the flow chart. The baseline characteristics age and gender, HAGOS results and single-leg-hop test result will be presented for the four groups (PAO, PRT, Cross-over and Drop-out) as illustrated I table 7.

Baseline patient characteristics

Baseline characteristics will be presented as seen in Table 1. Continuous variables will be presented as mean with standard deviation if normally distributed and as median with interquartile range if not normally distributed. Categorical variables will be presented as number and percentages. Baseline variables for the primary and secondary outcomes will be presented as part of the analysis, as seen in Table 2.

ANALYSIS

Outcome definitions

The prespecified primary outcome is the difference from baseline to 12 months follow-up in the subscale pain of the Copenhagen Hip and Groin Outcome Score (HAGOS) (14). The subscale consists of 10 items related to pain. Each item has five possible categories, ranging from 0-4 point. In accordance with the HAGOS protocol, the points will be converted to a score from 0-100, where 0 indicates severe problems and 100 indicates no problems. The minimal clinically relevant difference of HAGOS pain has been found to be 9.7 points (15). HAGOS is a valid and reliable questionnaire to collect patient reported outcome regarding hip and groin pain among young to middle-age patients (15,16). In addition, five key secondary outcomes will also be obtained. For the other five subscales of HAGOS (symptoms, physical function in daily living, physical function in sport and recreation, participation in physical activities and hip and groin related quality of life) and the single leg hop for a distance test, the outcome will be the difference from baseline to 12 months follow-up. In addition, the number of adverse and serious adverse events will be presented as the between group difference at 12 months follow-up. Usage of analgesics will be presented as the number of patients using analgesics at each assessment (yes/no). In addition, the patients who reported using analgesics will further be asked to report type of analgesics and frequency of use. The study has no

information on exact dose of various analgesics. The “Anchor question” will be presented as the number of participants in each group defining their hip at the assessment point compared to before the intervention, as much better, slightly better, the same, slightly worse, or much worse.

Analysis methods

Descriptive statistics will be presented as means with standard deviations (SD) for all normally distributed continuous variables and as median with interquartile ranges for all continuous variables that do not follow a normal distribution. Normal distribution will be determined by visual inspection of quantile plots and histograms. Categorical outcomes will be presented as numbers with percentage.

The difference between the two intervention groups, regarding the primary outcome and the continuous secondary outcomes, will be determined based on the intention-to-treat principle and thus includes all randomized patients regardless of actual treatment received. For the primary outcome, HAGOS pain, mixed effect models will be used with the patient as the random effect and assessment time, and intervention group along with the interaction between them as fixed effects. Patients who drops out will contribute with data to their respective groups until they drop out (i.e. imputations will not be applied). The intention-to-treat analysis will be adjusted for inclusion site and the time that the patients waits from baseline assessment to initiation of the intervention. This has been decided a priori since the waiting period for surgery could vary throughout the study period.

The categorical secondary outcomes will only be presented and thus not analysed, to tone down the use of p-values. Table 4, 5 and 6 illustrate this.

Missing data

As stated above, imputations will not be applied in this study. Instead each randomised patient will be included in the intention-to-treat analysis with the data collected. An attempt to collect data from all randomised patients will be made, see the section on withdrawing.

Additional analysis

A per-protocol analysis using the same analysis will be conducted. A priory “good compliance to the protocol” has been defined as a participation in at least 70% of the training sessions (1). Patients who do not comply with the randomised treatment will be excluded from this analysis. As-treated analysis will also be applied, using the same mixed effect model as described for the intention-to-treat, however the patients randomized to the exercise group (PRT) will further be divided into those who decides to cross-over to surgery and those who do not. Table 2 and 3 illustrates this.

In 2020-2021 the two countries were under lockdown in periods due to the COVID-19 pandemic. This resulted in postponed surgeries and amendments to the exercise protocol. A sensitivity analysis, excluding

all patients included before 2022 will therefore be made to assess the potential impact of the pandemic on the study.

Harms

Adverse and serious adverse events as defined by Biederman et al. (17) will be presented as number and percentage for each event. Depending on the number of adverse and serious adverse events during the trial the events will either be presented as illustrated in Table 5 or as text in the results section.

Statistical software

All statistical analyses will be performed in Stata version 17.0 (StataCorp LLC, College Station, TX, USA).

FIGURES

Figure 1. Flow chart of the participants in the PreserveHip trial randomised to either Periacetabular Osteotomy (PAO) or Progressive Resistance Training (PRT).

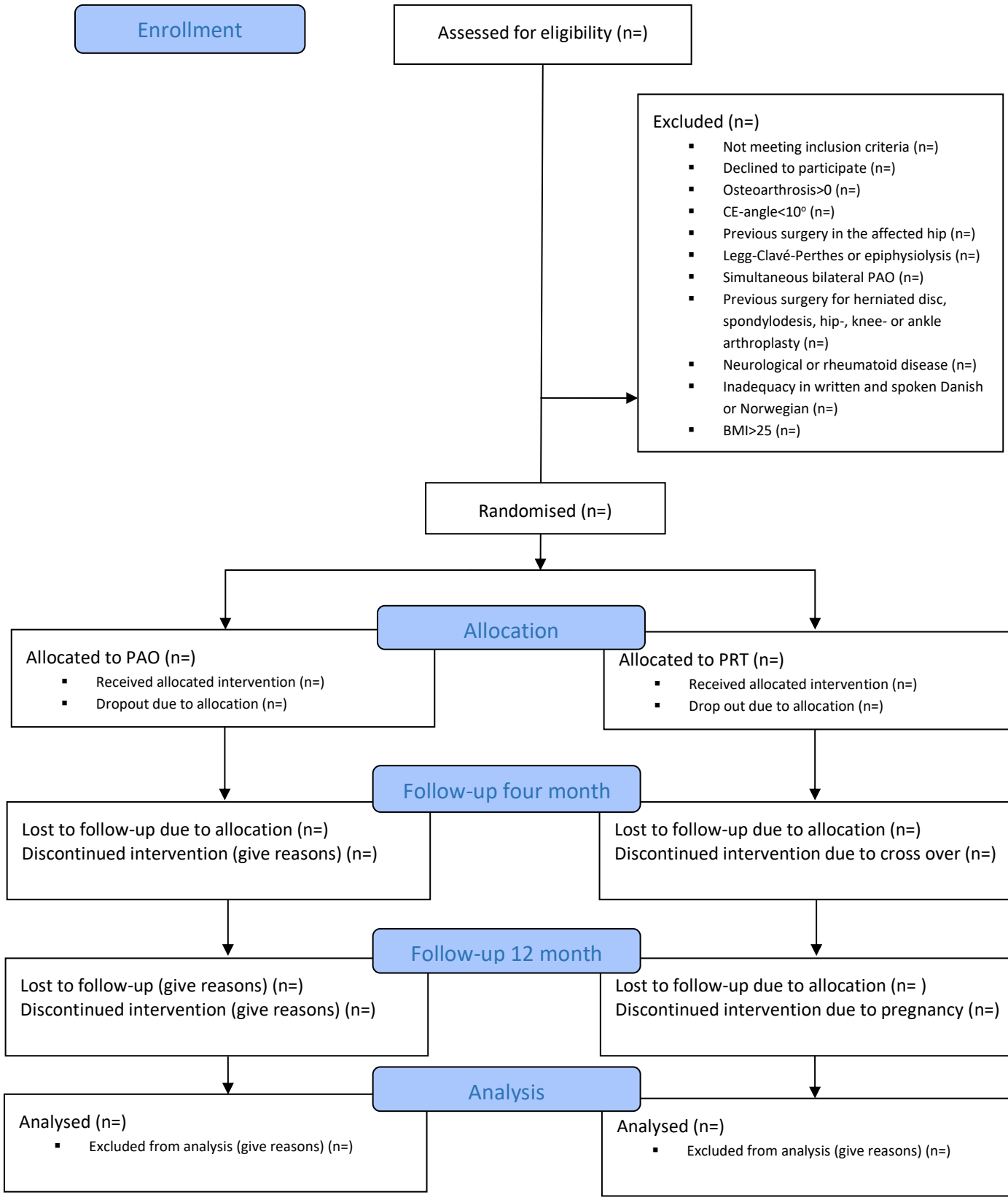
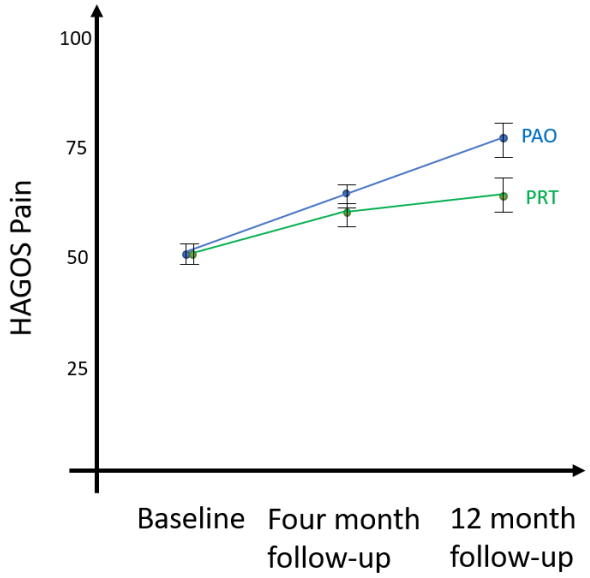


Figure 2: HAGOS pain change over time (baseline, 4 months, and 12 months after intervention). This figure is an example and is based on results from two trials reporting HAGOS Pain in a group of patients with hip dysplasia receiving PAO (6) and a group of patients with hip dysplasia receiving PRT (18).



TABLES

Table 1. Baseline characteristics for the two intervention groups.

	PAO group n =	Exercise group n =
Gender		
Age		
Height		
Weight		
CE-angle		
AI-angle		
Duration of hip symptoms		
0-6 months		
6-12 months		
1-2 years		
2-5 years		
5-10 years		
More than 10 years		
Civil status		
Married		
Cohabiting		
Single		
Divorced		
Widow/widower		
Not informed		
Educational level		
Primary school		
Vocational education		
High school or similar		
Short higher education		
Medium higher education		
Long higher education		
Other education		
Employment status		
During education		
In work		
In activation, sick leave, available, etc.		
Outside the labor market		
Other		
Alcohol consumption		
Under 2 items per week		
2-7 items per week		
8-14 items per week		
15-21 items per week		
22-30 items per week		
Over 30 items per week		
Smoking behaviour		
Never smoked		
Quit smoking		
Sometimes		
Daily		
Co-morbidities		

PAO = Periacetabular osteotomy. CE-angle = Wibergs centre edge angle. AI-angle = Acetabular Index angle

Table 2. Intention-to-treat and per-protocol analysis of the difference between the PAO group and the exercise group in improvement from baseline to one year after intervention.

	PAO			Exercise			Improvements between the two groups	
Intention-to-treat analysis								
	Baseline	Four month	One year	Baseline	Four month	One year	Crude	Adjusted
HAGOS								
Pain								
Symptoms								
Activities of daily living								
Sport and recreation								
Participation in activity								
Hip and groin related quality of life								
Single leg hop for distance								
Per-protocol analysis								
	Baseline	Four month	One year	Baseline	Four month	One year	Crude	Adjusted
HAGOS								
Pain								
Symptoms								
Activities of daily living								
Sport and recreation								
Participation in activity								
Hip and groin related quality of life								
Single leg hop for distance								

Outcomes presented as mean with 95% confidence interval. PAO = Periacetabular osteotomy. Adjusted: the analysis was adjusted for inclusion site and time from baseline assessment to intervention.

Table 3. As treated analysis of the difference between the PAO group, the exercise group and cross-over patients in improvement from baseline to one year after intervention.

	PAO			Exercise			Cross-over			Improvements between the three groups	
	Baseline	Four month	One year	Baseline	Four month	One year	Baseline	Four month	One year	Crude	Adjusted
HAGOS											
Pain											
Symptoms											
Activities of daily living											
Sport and recreation											
Participation in activity											
Hip and groin related quality of life											
Single leg hop for distance											

Outcomes presented as mean with 95% confidence interval. PAO = Periacetabular osteotomy. Adjusted: the analysis was adjusted for inclusion site and time from baseline assessment to intervention.

Table 4. Usage of painkillers.

	PAO group			Exercise group		
	Baseline	Four month	One year	Baseline	Four month	One year
Use of painkillers, n (%)						
Type of painkillers, n (%) Paracetamol NSAID Morfin/opiods Other painkillers						
Usage of painkillers, n (%) Never Monthly Weekly Daily						

Outcomes presented as numbers and percentages. PAO = Periacetabular osteotomy.

Table 5. Adverse and seriouse adverse events.

	PAO group	Exercise group
Adverse events n (%)		
Haematoma		
Delayed wound closure		
Dysaethesia of lateral femoral cutaneous nerve		
Malpositioning		
Heterotopic ossifications (Brooker I and II)		
Urinary tract infections		
Infection not requiring surgical revision		
Injuries related to the training interventions		
Seriouse adverse events, n (%)		
Avascular necrosis of the femoral head or acetabulum		
Nerve palsy		
Major bleeding		
Peroneal and femoral neurapraxia		
Deep vein thrombosis		
Pulmonary embolism		
Stress fracture of ischial bone and posterior column		
Intraarticular osteotomy		
Heterotopic ossifications (Brooker III and IV)		
Infection requiring surgical revision		
Loss of fixation/loss of reorientation		
Delayed or non-union of pubic, ischial or iliac bone		

PAO = Periacetabular osteotomy. Malpositioning; retroversion or insufficient reorientation (CE-angle not between 30º-40º or AI-angle not between 0º-10º). Major bleeding: administration of more than five blood units intraoperatively and postoperatively.

Table 6. Treatment related information within the study period measured at one-year follow-up

	PAO group	Exercise group
Training adherence		
Showed up for supervised sessions, mean (SD)		
Completion of all exercises during supervised sessions, mean (SD)		
Participated in at least 70% of supervised sessions within the first four months of PRT, n (%)		
Number of self-reported training sessions, mean (SD)		
Received other treatment in the hip, n (%)		
Type of other treatment in the hip, n (%)		
Work out		
Physiotherapy		
Chiropractor		
Osteopathy		
Painkillers		
Blockade		
Other surgery than PAO		
Else		

PAO = Periacetabular osteotomy.

Table 7. Presentation of baseline results among the included patients, stratified in four groups; PAO, exercise, cross-over and drop-out.

	PAO group[a] (n=)	Exercise group[a] (n=)	Cross over (n=)	Drop out (n=)
Gender				
Age				
HAGOS				
Pain				
Symptoms				
Activities of daily living				
Sport and recreation				
Participation in activity				
Hip and groin related quality of life				
Single leg hop for distance				

Outcomes presented as mean with standard deviation. PAO = Periacetabular osteotomy. [a]Without cross-over and drop out patients.

REFERENCES

1. Reimer LCU, Jakobsen SS, Mortensen L, Dalgas U, Jacobsen JS, Soballe K, et al. Efficacy of periacetabular osteotomy followed by progressive resistance training compared to progressive resistance training as non-surgical treatment in patients with hip dysplasia (PreserveHip) - a protocol for a randomised controlled trial. BMJ Open. 2019;9:e032782.

2. Mechlenburg I, Nyengaard JR, Rømer L, Søballe K. Changes in load-bearing area after Ganz periacetabular osteotomy evaluated by multislice CT scanning and stereology. Acta Orthop Scand. 2004;75(2):147–53.

3. Lerch TD, Steppacher SD, Liechti EF, Tannast M, Siebenrock KA. One-third of Hips After Periacetabular Osteotomy Survive 30 Years With Good Clinical Results, No Progression of Arthritis, or Conversion to THA. Clin Orthop Relat Res. 2017;475(4):1154–68.

4. Troelsen A, Elmengaard B, Søballe K. A new minimally invasive transsartorial approach for periacetabular osteotomy. J Bone Jt Surg - Ser A. 2008;90(3):493–8.

5. Larsen JB, Mechlenburg I, Jakobsen SS, Thilleman TM, Søballe K. 14-Year Hip Survivorship After Periacetabular Osteotomy: a Follow-Up Study on 1,385 Hips. Acta Orthop. 2020;91(3):299–305.

6. Jacobsen JS, Søballe K, Thorborg K, Bolvig L, Storgaard Jakobsen S, Hölmich P, et al. Patient-reported outcome and muscle–tendon pain after periacetabular osteotomy are related: 1-year follow-up in 82 patients with hip dysplasia. Acta Orthop. 2019;90(1):40–5.

7. Jacobsen JS, Jakobsen SS, Søballe K, Hölmich P, Thorborg K. Isometric hip strength impairments in patients with hip dysplasia are improved but not normalized 1 year after periacetabular osteotomy: a cohort study of 82 patients. Acta Orthop [Internet]. 2021;1–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/33538223

8. Pedersen ENG, Alkjær T, Søballe K, Simonsen EB. Walking pattern in 9 women with hip dysplasia 18 months after periacetabular osteotomy. Acta Orthop. 2006;77(2):203–8.

9. Nelson AE, Allen KD, Golightly YM, Goode AP, Jordan JM. A systematic review of recommendations and guidelines for the management of osteoarthritis: The Chronic Osteoarthritis Management Initiative of the U.S. Bone and Joint Initiative. Semin Arthritis Rheum. 2014;43(6):701–12.

10. Pennock AT, Bomar JD, Johnson KP, Randich K, Upasani V V. Nonoperative Management of Femoroacetabular Impingement: A Prospective Study. Am J Sports Med. 2018;46(14):3415–22.

11. Moher D, Hopewell S, Schulz KF, Montori V, Gotzsche PC, Devereaux PJ, et al. CONSORT 2010 Explanation and Elaboration: updated guidelines for reporting parallel group randomised trials. J Clin Epidemiol [Internet]. 2010;63(8):e1–37. Available from: http://dx.doi.org/10.1016/j.jclinepi.2010.03.004

12. Gamble C, Krishan A, Stocken D, Lewis S, Juszczak E, Doré C, et al. Guidelines for the content of statistical analysis plans in clinical trials. JAMA - J Am Med Assoc. 2017;318(23):2337–43.

13. Harrington D, D'Agostino RB, Gatsonis C, Hogan JW, Hunter DJ, Normand S-LT, et al. New Guidelines for Statistical Reporting in the Journal . N Engl J Med. 2019;381(3):285–6.

14. Thorborg K, Holmich P, Christensen R, Petersen J, Roos EM, Hölmich P, et al. The Copenhagen Hip and Groin Outcome Score (HAGOS): development and validation according to the COSMIN checklist.

Br J Sport Med. 2011;45(6):478–91.

15. Thomeé R, Jónasson P, Thorborg K, Sansone M, Ahldén M, Thomeé C, et al. Cross-cultural adaptation to Swedish and validation of the Copenhagen Hip and Groin Outcome Score (HAGOS) for pain, symptoms and physical function in patients with hip and groin disability due to femoro-acetabular impingement. Knee Surgery, Sport Traumatol Arthrosc. 2014;22(4):835–42.

16. Kemp JL, Collins NJ, Roos EM, Crossley KM. Psychometric Properties of Patient-Reported Outcome Measures for Hip Arthroscopic Surgery. Am J Sports Med. 2013;41(9):2065–73.

17. Biedermann R, Donnan L, Gabriel A, Wachter R, Krismer M, Behensky H. Complications and patient satisfaction after periacetabular pelvic osteotomy. Int Orthop. 2008;32(5):611–7.

18. Mortensen L, Schultz J, Elsner A, Jakobsen SS, Søballe K, Jacobsen JS, et al. Progressive resistance training in patients with hip dysplasia: A feasibility study. J Rehabil Med. 2018;50(8):751–8.