Changes in Sports Activity After Periacetabular Osteotomy

A Qualitative and Quantitative Analysis

Vincent J. Leopold,*† MD, Adrian Szarek,† MS, Christian Hipfl,† MD, Matthias Pumberger,† MD, Carsten Perka,† MD, Sebastian Hardt,† MD, and Jannis Löchel,† MD
Investigation performed at the Center for Musculoskeletal Surgery, Charité–University Hospital, Berlin, Germany

Background: Patients undergoing periacetabular osteotomy (PAO) for symptomatic developmental dysplasia of the hip are usually young and active with high functional demands. Those who participate in sports seek surgical therapy to resume or maintain sports activities. There is little evidence regarding the postoperative level of activity and the extent to which sports activity changes after PAO both qualitatively and quantitatively.

Purpose: The aim of this study was to determine the change in activity level as measured using the University of California Los Angeles (UCLA) activity score and the changes in qualitative and quantitative sports activity.

Study Design: Case series; Level of evidence, 4.

Methods: This was a retrospective analysis of prospectively collected data of 123 hips in 111 patients who underwent PAO for developmental dysplasia of the hip between January 2015 and June 2017. UCLA activity score, International Hip Outcome Tool 12, and Subjective Hip Value, as well as practiced sports, frequency and duration of sports activity, and time to return to sports, were assessed. Eventual changes in practiced sports and reasons for those changes were recorded.

Results: Of the participating patients, 85% were female and 15% were male. The mean patient age at the time of surgery was 27.7 ± 7.3 years. Mean follow-up was 63 ± 10 months. UCLA score (5.08 ± 2.44 vs 6.95 ± 1.74; $P < .001$), International Hip Outcome Tool 12 (41.4 ± 22.2 vs 72.6 ± 22.9; $P < .001$), and Subjective Hip Value (42.8 ± 24.3 vs 80.4 ± 17.8; $P < .001$) increased significantly from pre- to postoperatively. Significantly more patients participated in low-impact sports postoperatively (31.7% vs 52%; $P = .001$). Participation in high-impact sports decreased (42.3% vs 36.6%; $P = .361$). The overall sports activity rate increased significantly (78.8% vs 90.8%; $P = .008$). Quantitatively, sports frequency in times per week ($P < .001$) as well as length of exercise per time ($P = .007$) increased significantly. A total of 52 patients (42%) changed sports activities postoperatively. Of these, 35 (28.4%) reported having stopped previously practiced sports after surgery, while 17 (13.8%) reported having started new sports. Reasons for starting and stopping certain sports varied and included hip- and non–hip related ones. In only 2 cases was physician's advice given as a reason for changing the sport.

Conclusion: Patients can improve their sports activity both qualitatively and quantitatively after PAO. However, a relevant proportion of patients adjusts their sports activities for a variety of hip-related and non–hip related reasons.

Keywords: periacetabular osteotomy; return to sports; developmental dysplasia of the hip; hip preservation surgery

Developmental dysplasia of the hip (DDH) is the most common cause for early, secondary osteoarthritis of the hip, resulting in functional impairment and immobilization.[1,8,12,23,25] With improved diagnostics and knowledge of both pathology and treatment options, affected patients more frequently present to orthopaedic surgeons in time for joint-preserving surgery.[18] Periacetabular osteotomy (PAO) is the standard for joint-preserving surgical treatment and has shown good long-term results.[2,5-7,16,22]

At the time of indication, patients are usually young and have a high functional demand. Those who participate in sports seek surgical therapy to resume or maintain sports activities.[4,21,22]

*Address correspondence to Vincent J. Leopold, MD, University Hospital Berlin, Charitéplatz 1, 10117 Berlin, Germany (email: vincent.leopold@charite.de).
†Department of Orthopaedic Surgery and Traumatology, Charité Berlin, University Hospital, Berlin, Germany.

Submitted May 9, 2022; accepted October 17, 2022.

The authors declared that they have no conflicts of interest in the authorship and publication of this contribution. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

The American Journal of Sports Medicine
2023;51(2):481–486
DOI: 10.1177/03635465221142320

However, there is little evidence on the extent to which sports activity changes, both qualitatively and quantitatively, after PAO and what the reasons for possible change are.

The current study first aimed to compare the change in activity level as measured using the University of California Los Angeles (UCLA) activity score. A second aim was to assess qualitative and quantitative changes in activity pattern and sports practiced. The authors hypothesized that patients would be able to return to their preoperative activity level as measured using the UCLA activity score and continue sporting activity as before surgery.

METHODS

Patients

We conducted a retrospective analysis of prospectively collected data from our institutional database. Prior approval of the local ethics committee was obtained (EA1/052/21). Patients who underwent PAO between January 2015 and June 2017 were included. Inclusion criteria were a primary diagnosis of symptomatic DDH based on defined parameters (further described below) as well as complete information on preoperative and postoperative activity levels and sports participation at follow-up (further described below), completed hip questionnaire for preoperative and postoperative functional status, and informed consent. Exclusion criteria were treatment with PAO for indications other than symptomatic DDH, osteoarthritis grade >1 according to Tönnis, incomplete data, or missing informed consent.

A total of 202 cases were included during the study period. Six were excluded because of a diagnosis other than DDH, and 73 were lost to follow-up, resulting in a final study cohort of 123 hips in 111 patients. Of these, 85% were female and 15% were male. A PAO was performed on the right hip in 53% of cases. In 24 cases, additional open femoral head-neck osteochondroplasty was performed. In 1 case, combined head-neck osteochondroplasty and subspine decompression was performed. Furthermore, in 1 case, subtrochanteric derotating osteotomy was performed. The mean patient age at the time of surgery was 27.7 ± 7.3 years, and mean body mass index was 24.3 ± 4.7. The mean follow-up was 63 ± 10 months. For a detailed overview of patient selection, see Figure 1.

Hip dysplasia was diagnosed from standing anteroposterior radiographs. All hips had ≥1 radiographic abnormality, including a lateral center-edge angle according to Wiberg of <25°,[17] acetabular inclination according to Tönnis of >10°,[17] and femoral head extrusion index according to Heyman and Herndon[11] of >26%. Femoral head congruency was determined preoperatively via functional radiographs in 30° of abduction and was good in all hips. All hips had osteoarthritis grade ≤1 according to Tönnis.[14]

Data Collection

The pre- and postoperative activity level and hip function were assessed as part of the routine assessment of the patients. Activity level was assessed using the UCLA activity score.[3] Hip function was assessed using the International Hip Outcome Tool 12 and Subjective Hip Value, as these have been previously validated and recommended for young active patients in the context of hip joint preservation surgery.[9,15] Patient-reported outcome measures and sports activity were collected at follow-up via a hip-specific questionnaire (see Appendix, available in the online version of this article).

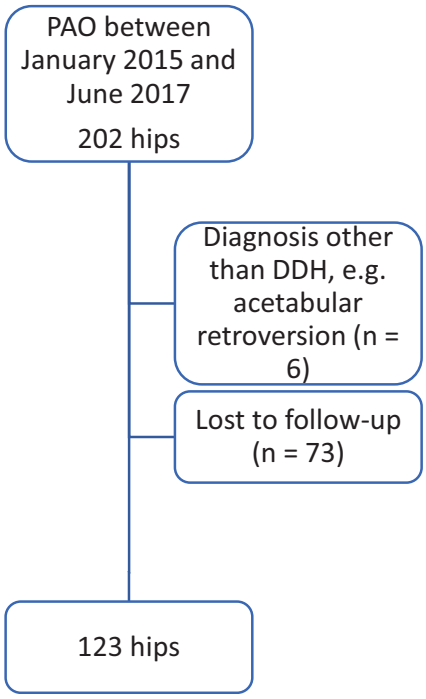

Figure 1. Flowchart showing study population and reasons for exclusion. DDH, developmental dysplasia of the hip; PAO, periacetabular osteotomy.

The qualitative pre- and postoperative sports activity was assessed using a questionnaire developed for this purpose. For simplification, common sports (cycling, mountaineering, alpine skiing, fitness training, tennis, basketball, soccer, handball, volleyball, hiking, golf, long walks, Nordic walking, running/jogging) were given in a list. Sports outside the given list were collected via free-text answer. The option "no sports" was also listed. Multiple answers were possible. The activities were divided into high-impact sports (tennis, basketball, soccer, handball, volleyball, alpine skiing, mountaineering, running/jogging, dancing, martial arts) and low-impact sports (cycling, long walks, Nordic walking, hiking, fitness training, swimming, yoga, horseback riding), as previously defined in the literature.[13] Patients were asked if they participated in other sports after surgery than before surgery. In the event of a postoperative change in the sports practiced, patients were asked for the reason of change. Responses were grouped into hip-related and non–hip related reasons.

Quantitative sports activity was recorded by sports frequency in times per week with a ranking of 0, 1, 2, 3, 4, or

>4 times per week. In addition, the duration of sports activity each time was recorded in minutes. Patients could rank their sports activity on a scale from 0 to 15, 16 to 30, 31 to 60, 61 to 120, and >120 minutes per session.

Furthermore, the time between surgery and return to sports activity was recorded in weeks. Patients could rank themselves (1) between 1 and 3 months, (2) between 3 and 6 months, (3) after >6 months, and (4) no return to sports.

Patients were further asked to what extent PAO had subjectively affected their sports ability. They could choose among (1) improved, (2) worsened, and (3) not influenced. Qualitative and quantitative aspects were collected at the time of follow-up using the aforementioned questionnaire.

Statistical Analysis

Frequency rates, means, and ranges were used to describe basic patient characteristics. Normal distribution was tested using the Shapiro-Wilk test. For normally distributed data, the *t* test was used, and for nonnormally distributed data, the Mann-Whitney *U* test was used to determine significant differences between continuous data. The chi-square test was used for categorical data. For nonparametric data, the Wilcoxon signed-rank test was used. A P value of <.05 was considered statistically significant. Microsoft Excel Version 16.16.2 was used to document the collected data. The collected data were analyzed using IBM SPSS 25 (SPSS, Inc).

RESULTS

Radiologic Measurements

Radiologic parameters relevant for DDH, including lateral center-edge angle (16.2° ± 6.1° to 29.3° ±5.8°; $P < .001$), acetabular inclination (13.3° ± 6.6° to 1.3° ± 7.4°; $P < .001$), and femoral head extrusion index (23.7% ± 8.2% to 9.6% ± 8.6%; $P < .001$), were significantly improved pre- to postoperatively.

Activity Level and Hip Function

Activity level as measured using the UCLA activity score improved significantly from preoperatively to follow-up (5.1 ± 2.4 to 7 ± 1.7; $P < .001$). The International Hip Outcome Tool 12 improved significantly from preoperatively to follow-up (41.4 ± 22.2 to 72.6 ± 22.9; $P < .001$). The Subjective Hip Value also improved significantly from preoperatively to follow-up (42.8 ± 24.3 to 80.4 ± 17.8; $P < .001$).

Changes in Qualitative Sports Activity

At follow-up, the percentage of patients participating in low-impact sports increased significantly preoperatively (39/123 or 31.7%) to postoperatively (64/123 or 52%) ($P = .001$). The percentage of patients participating in high-impact sports decreased from preoperatively (52/123 or 42.3%) to postoperatively (45/123 or 36.6%), but this difference was not significant ($P = .361$). Within the listed high-impact sports, soccer and basketball stand out as sports that involve both full-speed running and cutting activity. The number of patients playing soccer decreased from preoperatively (16/123 or 13%) to follow-up (8/123 or 6.5%) ($P = .085$). The number of patients playing basketball also decreased from preoperatively (4/123 or 3.3%) to follow-up (1/123 or 0.8%) ($P = .175$). Return-to-sports rate was 50% for soccer and 20% for basketball. These changes were not significant. The percentage of patients who reported participating in sports activity increased significantly (78.8% vs 90.8%; $P = .008$).

For a detailed overview of the sports practiced, see Figure 2.

A total of 52 patients (42%) changed sports activities postoperatively. Of these, 35 (28.4%) reported having stopped previously practiced sports after surgery, while 17 (13.8%) reported having started new sports. Of the patients who stopped playing sports postoperatively, 11 (8.9%) reported having stopped for reasons unrelated to surgery, 23 patients (18.7%) reported lower exercise tolerance/pain as the reason, and 1 patient (0.8%) reported other reasons. Of the patients who started new sports postoperatively, 9 (7.3%) reported having started new sports that were not possible preoperatively due to hip discomfort, while 8 (6.5%) reported having started new sports to improve hip function. Only in 2 cases was physician's advice given as a reason for changing the sport.

Changes in Quantitative Sports Activity

At follow-up, the frequency in sports activity per week measured using the ranking mentioned above was significantly higher postoperatively ($P < .001$). For a summary of the data on sports frequency, see Figure 3.

In 73% of the participating patients, there were differences in sports frequency pre- and postoperatively. In 49.6% of the patients, sports frequency was higher postoperatively than preoperatively, while it was higher preoperatively in 23.6% of the patients.

The length of exercise per session as measured using the abovementioned scale also increased significantly pre- to postoperatively ($P = .007$).

For a summary of the data on sports length, see Figure 4.

Time to Return to Sports

Most patients resumed sports activity after >6 months (42%) or 3 to 6 months (38%); 17% reported resuming sports after 1 to 3 months. No return to sports occurred in 3% of cases.

Subjective Influence on Sports Ability

With regard to the subjective effect of PAO on their sports ability, of 123 participating patients, 58.1% reported that the surgery had subjectively improved their sports ability,

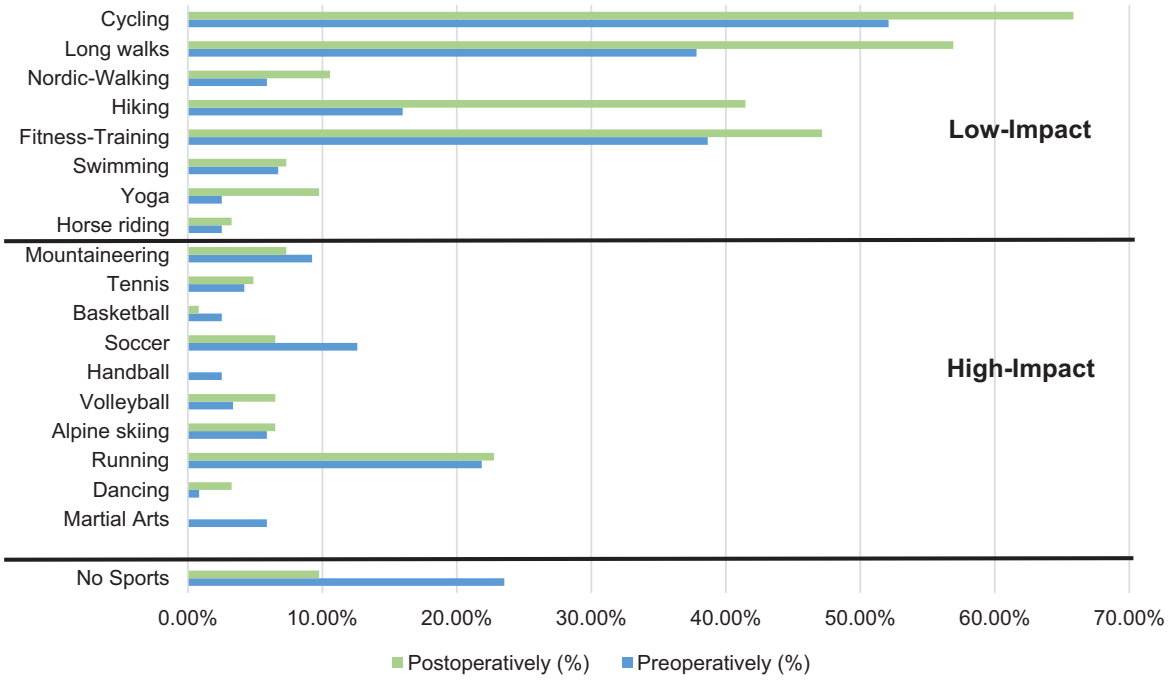

Figure 2. Sports practiced pre- and postoperatively divided into low- and high-impact sports. Multiple answers possible.

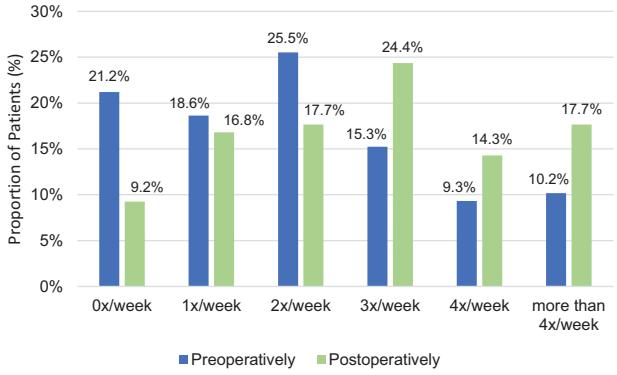

Figure 3. Sports frequency in times per week pre- and postoperatively. Across the study population, sports frequency improved significantly ($P < .001$).

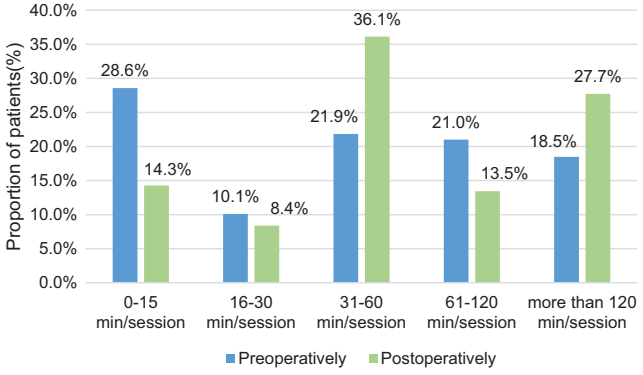

Figure 4. Length of sports activity in minutes per session pre- and postoperatively. A significant increase was observed across the study population ($P = .007$).

18.8% reported that the surgery had subjectively decreased their sports ability, and 23.1% of patients reported that the surgery had not subjectively affected their sports ability.

Male Versus Female Return to Sports

Female patients (85% of the study population) reported a return to sports after 3 to 6 months (41%). Male patients (15% of the study population) reported a return to sports after >6 months in most cases (61%); 49% of the female patients and 42% of the male patients returned to their preoperative sport.

DISCUSSION

To our knowledge, there is no evidence on pre- to postoperative changes in sports activity in patients undergoing PAO and the underlying reasons for those changes. To our knowledge, this is the first study to provide a detailed analysis of these adjustments in patients undergoing PAO for DDH. The main finding of this study was that the activity level significantly increased after PAO. The proportion of patients who practiced sports increased significantly pre- to postoperatively. However, qualitatively, there was a significant shift toward low-impact sports. From a quantitative point of view, patients were able to increase both

sports frequency and duration postoperatively. Most patients returned to sports activities 6 months after PAO.

It was previously shown that active patients as measured using the UCLA activity score could maintain their activity level[21] or—in patients with low or moderate preoperative activity levels—could improve their activity level postoperatively. Patients with very high preoperative activity levels showed decreased activity levels postoperatively.[22] However, these studies assessed only athletic activity by means of the UCLA activity score,[20-22] lacking in qualitative and quantitative analysis of sports activities. In our cohort, the preoperative activity level was moderate, as measured using the UCLA activity score, and improved to levels previously defined as "active" similar to the literature.[4,21,22]

A study by Takahashi et al[24] examined postoperative sports participation in 43 middle-aged patients with DDH who underwent curved periacetabular osteotomy. Pre- and postoperative sports activity participation rates were 55.8% and 72.1%, respectively, and mostly low-impact sports were practiced. Return to sports was at an average of 12 months postoperatively, and weekly frequencies of athletic activity did not change significantly. In our study, patients were overall younger, and more individuals practiced sports preoperatively (78.8%) as well as postoperatively (90.8%). The proportion of patients participating in low-impact sports significantly increased from 31.7% to 52%, and the proportion decreased from 42.3% to 35.8% for high-impact sports in our cohort.

Reasons for changing sports can vary and go beyond hip disorders. It was previously shown that the main reason for a postoperative increase of sports activity after PAO was reduced hip pain. Previously identified reasons for a decrease of sports activity postoperatively were various. Persistent hip pain, continued concerns for preserving the hip joint, medical advice, and a change in life circumstances were mentioned.[4] However, these analyses lack details on the specific sports and their practice.

In our cohort, 42% of the patients changed sports after PAO. Of the 14% of patients who started new sports postoperatively, about half reported resolution of preoperative symptoms to be the reason, while the other half started new sports to improve the hip function. Of the 28.4% of patients who had stopped sports, one-third indicated reasons unrelated to the operated hip joint, while the other two-thirds indicated persistent hip discomfort or reduced exercise tolerance of the hip. Only in 2 cases was a physician's recommendation given as the reason for discontinuing a sport.

It has been previously shown that high levels of athletic activity in patients with DDH lead to an earlier onset of hip symptoms. During the orthopaedic consultation, these very active patients are often initially recommended to exhaust nonoperative therapy, which includes adjusting sports activity.[18] However, the question arises whether an adjustment of the activity level is also necessary after a successful PAO, with physiologic acetabular coverage ideally being achieved.[19]

In a study by Hara et al,[10] 161 patients (183 hips) were investigated to determine whether exercise after PAO affected the progression of osteoarthritis at 100-month follow-up. It was found that higher activity did not cause progression of osteoarthritis. However, with a mean age of 42 years and a participation of 5% of the study population in high-impact sports, possible conclusions for active and very active patients seem limited here.

Overall, the evidence of the influence of high-impact sports on osteoarthritis progression after PAO is scarce, thus leading to a lack of uniform recommendations for sports after PAO.

This study had several limitations. First was the retrospective study design and potential recall bias in patients' responses to possible change of sport as well as sport frequency and duration. However, it can be assumed that patients remembered the changes in their sports activity in the relatively short follow-up. Second, the dropout in our cohort was relatively high. Nevertheless, the final study population was still relatively large compared with that in previous studies assessing athletic activity after PAO.

CONCLUSION

Activity level increases after PAO. While patients can increase their quantitative sporting activity, qualitatively there is a shift toward low-impact sports. Reasons for changing sports are various and include hip-related and non–hip related reasons.

ORCID iD

Vincent J. Leopold https://orcid.org/0000-0002-3476-4602

REFERENCES

1. Agricola R, Heijboer MP, Roze RH, et al. Pincer deformity does not lead to osteoarthritis of the hip whereas acetabular dysplasia does: acetabular coverage and development of osteoarthritis in a nationwide prospective cohort study (CHECK). *Osteoarthritis Cartilage*. 2013;21(10):1514-1521.
2. Ahmad SS, Giebel GM, Perka C, et al. Survival of the dysplastic hip after periacetabular osteotomy: a meta-analysis. Published online September 27, 2021. *Hip Int.* doi:10.1177/11207000211048425
3. Amstutz HC, Thomas BJ, Jinnah R, et al. Treatment of primary osteoarthritis of the hip: a comparison of total joint and surface replacement arthroplasty. *J Bone Joint Surg Am*. 1984;66(2):228-241.
4. Bogunovic L, Hunt D, Prather H, Schoenecker PL, Clohisy JC. Activity tolerance after periacetabular osteotomy. *Am J Sports Med*. 2014;42(8):1791-1795.
5. Clohisy JC, Ackerman J, Baca G, et al. Patient-reported outcomes of periacetabular osteotomy from the prospective ANCHOR Cohort Study. *J Bone Joint Surg Am*. 2017;99(1):33-41.
6. Clohisy JC, Barrett SE, Gordon JE, Delgado ED, Schoenecker PL. Periacetabular osteotomy in the treatment of severe acetabular dysplasia: surgical technique. *J Bone Joint Surg Am*. 2006;88(suppl 1, pt 1):65-83.
7. Clohisy JC, Schutz AL, St John L, Schoenecker PL, Wright RW. Periacetabular osteotomy: a systematic literature review. *Clin Orthop Relat Res*. 2009;467(8):2041-2052.

8. Cooperman DR, Wallensten R, Stulberg SD. Acetabular dysplasia in the adult. *Clin Orthop Relat Res*. 1983;175:79-85.
9. Griffin DR, Parsons N, Mohtadi NG, Safran MR; Multicenter Arthroscopy of the Hip Outcomes Research Network. A short version of the International Hip Outcome Tool (iHOT-12) for use in routine clinical practice. *Arthroscopy*. 2012;28(5):611-616.
10. Hara D, Hamai S, Fukushi JI, et al. Does participation in sports affect osteoarthritic progression after periacetabular osteotomy? *Am J Sports Med*. 2017;45(11):2468-2475.
11. Heyman CH, Herndon CH. Legg-Perthes disease: a method for the measurement of the roentgenographic result. *J Bone Joint Surg Am*. 1950;32(4):767-778.
12. Ipach I, Mittag F, Syha R, et al. Indications for total hip arthroplasty in young adults—idiopathic osteoarthritis seems to be overestimated. *Rofo*. 2012;184(3):239-247.
13. Klein GR, Levine BR, Hozack WJ, et al. Return to athletic activity after total hip arthroplasty: consensus guidelines based on a survey of the Hip Society and American Association of Hip and Knee Surgeons. *J Arthroplasty*. 2007;22(2):171-175.
14. Kovalenko B, Bremjit P, Fernando N. Classifications in brief: Tönnis classification of hip osteoarthritis. *Clin Orthop Relat Res*. 2018; 476(8):1680-1684.
15. Krueger DR, Leopold VJ, Schroeder JH, Perka C, Hardt S. Correlation of the subjective hip value with validated patient-reported outcome measurements for the hip. *J Clin Med*. 2020;9(7):2179.
16. 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):1154-1168.
17. Massie WK, Howorth MB. Congenital dislocation of the hip, part I: method of grading results. *J Bone Joint Surg Am*. 1950;32(3):519-531.
18. Matheney T, Zaltz I, Kim YJ, et al. Activity level and severity of dysplasia predict age at Bernese periacetabular osteotomy for symptomatic hip dysplasia. *J Bone Joint Surg Am*. 2016;98(8):665-671.
19. Novais EN, Duncan S, Nepple J, et al. Do radiographic parameters of dysplasia improve to normal ranges after Bernese periacetabular osteotomy? *Clin Orthop Relat Res*. 2017;475(4):1120-1127.
20. Novais EN, Heyworth B, Murray K, et al. Physical activity level improves after periacetabular osteotomy for the treatment of symptomatic hip dysplasia. *Clin Orthop Relat Res*. 2013;471(3):981-988.
21. Okoroafor UC, Pascual-Garrido C, Schwabe MT, et al. Activity level maintenance at midterm follow-up among active patients undergoing periacetabular osteotomy. *Am J Sports Med*. 2019;47(14):3455-3459.
22. Petrie JR, Novais EN, An TW; ANCHOR Study Group, Clohisy J. What is the impact of periacetabular osteotomy surgery on patient function and activity levels? *J Arthroplasty*. 2020;35(6)(suppl):S113-S118.
23. Reijman M, Hazes JM, Pols HA, Koes BW, Bierma-Zeinstra SM. Acetabular dysplasia predicts incident osteoarthritis of the hip: the Rotterdam study. *Arthritis Rheum*. 2005;52(3):787-793.
24. Takahashi Y, Takahira N, Uchiyama K, et al. Sports activity participation after curved periacetabular osteotomy for acetabular dysplasia. *BMC Musculoskelet Disord*. 2020;21(1):637.
25. Terjesen T. Residual hip dysplasia as a risk factor for osteoarthritis in 45 years follow-up of late-detected hip dislocation. *J Child Orthop*. 2011;5(6):425-431.