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ORIGINAL PAPER

# Prior arthroscopic treatment for femoro-acetabular impingement does not compromise hip arthroplasty outcomes: a matched-controlled study with minimum two-year follow-up

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## Abstract

**Background** Femoro-acetabular impingement (FAI) is known as a predisposing factor in the development of osteoarthritis of the hip. In order to treat this condition, hip arthroscopy is considered as the gold standard in recent years. The number of performed hip arthroscopies has risen immensely. However, a number of patients with poor outcome after hip arthroscopy will require further surgical intervention, sometimes even conversion into THR (total hip replacement). The purpose of this study was to analyze whether outcomes of THR are affected by prior hip arthroscopy in these patients.

**Methods** Patients who underwent a THR following an ipsilateral hip arthroscopy were matched to a control group of THR patients with no history of prior ipsilateral hip surgery. Matching criteria were age, sex, body mass index, implants used, and surgical approach. Modified Harris Hip Score, surgical time, presence of heterotopic ossification, and post-operative complication were prospectively compared at a minimum two year follow-up.

**Results** Thirty-three THR after hip arthroscopy patients were successfully matched to control patients. There was no significant difference in mHHS between both groups (FAI treatment group 92.8 vs. control group 93.8, $p = 0.07$). However, FAI treatment group showed a lower mHHS score pre-operatively (48 vs. 60, $p = 0.002$). There was no significant difference in surgical time and post-operative complication rate. No heterotopic ossification could be found.

**Conclusion** A prior hip arthroscopy has no affect to clinical outcomes of subsequent THR.

**Keywords** Hip arthroscopy · FAI · Outcome · Total hip replacement · Complication

## Introduction

Femoro-acetabular impingement (FAI) is known as a predisposing factor in the development of osteoarthritis of the hip [1–4]. In order to treat this condition, hip arthroscopy has emerged as a safe and effective method and is considered as the gold standard nowadays. The historical development has been precisely documented, and the first recorded hip arthroscopy has been performed as early as 1931 [5]. The number of performed hip arthroscopies has risen immensely in recent years [6–8]. This was accompanied by the development of sophisticated arthroscopic techniques and approaches and by increasing numbers of studies [9, 10]. The latter included the comparison of hip arthroscopy with open treatment by surgical hip dislocation [11]. Studies also evaluated the learning curve of the arthroscopic technique [12]. Several studies have shown significant improvements in patient-related outcomes (PRO) [13–16]. However, after a failed hip arthroscopy, some patients will require further surgical intervention up to total hip replacement (THR) at a later stage, whether due to a poor indication or outcome or due to the physiological aging process [17]. Looking at total knee arthroplasty, there is some evidence that prior knee arthroscopy has some negative effect on the clinical outcome after total knee arthroplasty [18, 19]. Only a few studies analyzed the effect of a previous hip arthroscopy on the outcome after total hip arthroplasty [20–24]. While most of these studies report no effect, there is one study that found some possible negative effect on the functional and clinical outcome [22]. The aim of this work is to analyze whether a previous hip arthroscopy affects the outcome after a subsequent hip arthroplasty.

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## Methods and material

After institutional review board approval (F-2017-028, Landesaerztekammer Baden-Wuerttemberg, Germany), we identified patients via our institutional database and performed a retrospective analysis of prospectively collected data. The previously performed power analysis revealed a sample size of 30 individuals with a power of 0.66 and modified Harris Hip Score (mHHS) was set as the primary outcome measure. We could identify 49 patients that underwent ipsilateral hip arthroscopy before THR between 2009 and 2014. For 33 patients, data was available at minimum 2-year follow-up (study group). This cohort was matched to a group of patients with minimum two year follow-up who had no history of ipsilateral hip arthroscopy before their THR (control group). Matching criteria were exact age, sex, body mass index, implants used, and same surgical approach. As PRO score, all patients reported mHHS preoperatively and at follow-up. In addition, we noted any complications, differences in operative time, and presence of heterotopic ossification (HO) using the Brooker classification at anteroposterior and axial hip radiographs [25].

### Surgical technique

**Hip arthroscopy** The surgical procedure was performed under general anesthesia in the supine position using a traction table and perineal post. Two standard portals were used for each arthroscopy (midanterior and anterolateral portal). First, a diagnostic arthroscopy was performed, and the labrum, chondral damage, and additional intra-articular injuries were assessed. Cam impingement was treated with femoroplasty, and pincer impingement was treated with acetabuloplasty using a burr under the guidance of fluoroscopy. In patients with labral tears, the labrum was repaired whenever possible. If repair was not possible, the labrum was debrided until stable. Chondral damage was treated with debridement until a stable border was received and in the case of exposed bone, a microfracture was performed. The capsule was not repaired routinely.

**Total hip arthroplasty** All THRs were performed under general anaesthesia. In our institution, three different approaches are usually used: direct anterior approach and lateral approach in supine position and posterior approach in lateral decubitus position. After excision of soft tissue, the acetabulum was reamed and the cup and liner were implanted. In a next step, the femoral head was resected and the stem and head component were implanted. In younger patients, a short-stem prosthesis was used. All stems were implanted cementlessly. In all patients, a hemovac was used.

### Rehabilitation after THR

In the case of short-stem prosthesis, mobilization was allowed with partial load bearing of 15 to 20 kg for four weeks post-operatively. Patients treated with conventional stems were allowed full weight bearing as tolerated. All patients were mobilized using our institutional fast-track pathway that included mobilization on the day of THR surgery. As deep vein thrombosis (DVT) prophylaxis, low molecular weight heparin (LMWH) was used. To prevent heterotopic ossifications, etoricoxib (COX-2-inhibitor) in a daily dose of 90 mg for 14 days was used. After the inpatient surgery, all patients started a rehabilitation program after six to ten days. Radiographic follow-up was scheduled at six weeks, one year, and then every two years post-operatively.

### Statistical analysis

Statistical analyses were performed using SPSS Statistics 24 (IBM; Armonk, NY). A power analysis was performed and a sample size of 23 was computed to achieve 90% power. Continuous variables were compared using paired Student's *t* test. Categorical variables were tested using the Fisher exact test. A $p$ value of less than .05 was considered to be statistically significant.

## Results

The study group consisted of 33 patients that underwent a THR with prior arthroscopic treatment of the ipsilateral hip. There were 21 male and 12 female patients with a mean age of 52.8 years (33–69 years) at the time of THR. Based on the previously stated matching criteria, the consistence of the control group showed no significant difference concerning gender, age, weight, height, and body mass index (BMI). As the approach used for the THRs was part of the matching criteria, there was no difference between both groups: 20 posterior, 12 direct anterior, and one lateral.

Mean age of the control group was 55.0 years (35–69 years) at the time of THR (Table 1). The survival rate was 100% in both groups. None of the implanted hip endoprostheses had to be revised.

The study group was also analyzed with regard to intraoperative findings at the time of arthroscopy. All 33 patients had a FAI (20 patients combined FAI, 13 patients FAI CAM), 30 patients had a labrum lesion (16 labral repair, 14 labrum debridement), and 31 patients had cartilage damage of the acetabulum.

In the study group, the mean interval between arthroscopy and THR was 16.3 months (SD ± 13.3, 2–58 months). The mean follow-up (FU) time after THR was 45.6 months in the study group, respectively, 39.0 months in the control group.

**Table 1** Demographics (m, male; f, female; BMI, body mass index; THR, total hip replacement)

| | Gender | Age at THR (years) | BMI (kg/m$^2$) |
|---|---|---|---|
| Study group, $n = 33$ | 21m, 12f | 52.8 ± 8.4 (33–69) | 27.7 ± 4.2 (20–41) |
| Control group, $n = 33$ | 21m, 12f | 55.0 ± 8.2 (33–69) | 27.1 ± 3.4 (19–40) |
| $p$ value | | 0.3 | 0.5 |

The analysis of the patient-related outcomes showed no significant difference in mean mHHS between both groups at the time of FU (study group 92.8 vs. control group 93.8, $p = 0.7$). However, the study group showed a significant lower mHHS score pre-operatively (48.0 vs. 60.3, $p = 0.002$). Within both groups, the mHHS showed a significant improvement at follow-up. A mean improvement of 44.8 points within the study group and of 33.5 points within the control group was observed (Table 2).

Toennis grade of osteoarthritis before THR was significantly higher in the control group. There was no significant difference in surgical time of THR and post-operative complication rate (Table 3). The analysis of the radiographs showed no appearance of new heterotopic ossifications. In both groups, there were no signs for mechanical loosening, component migration, or any other complication at the time of FU.

## Discussion

This prospective matched-controlled study focused on the clinical outcome of THR patients with a previous ipsilateral hip arthroscopy. At the time of FU, there was no significant difference in average mHHS, surgical time, or post-operative complication rate between the two groups. There was also no newly occurred heterotopic ossification present at FU.

The mHHS was chosen as the primary outcome measure.

In its original version, the Harris Hip Score was designed to measure the clinical outcome of severe secondary osteoarthritis after trauma with hip dislocation and fractures of the acetabulum in a population of young men [26]. The commonly used modification of the HHS (mHHS) records only the subjective evaluation of the patient. The score is well established measuring outcomes after THR as well as after arthroscopies of the hip [27, 28]. For the latter, validity was proven, and reliability was examined in prospective studies [29, 30] which showed correlation of the mHHS with subjective patient satisfaction after hip arthroscopy over a period of two years.

In this study, no significant difference in mean mHHS between both groups at the time of FU was found. However, the pre-operative mHHS in the study group was significantly lower.

To approach an explanation for this finding, it has to be considered that the mHHS represents a subjective evaluation of the patient and reflects patient satisfaction as stated above. The study group represents a subset of patients who had progression of hip disease that required THR. The study group also showed a lower degree of arthrosis pre-operatively. In summary, the assumption suggests that there were additional causes other than arthrosis severity, such as microinstability, which led to a worsening of the mHHS. However, the study group showed a higher delta overall, so that this group clearly benefited from THR. In that respect, the average interval between arthroscopy and THR of only 16.3 months should be also noted. Interestingly, Haughom et al. found reverse results with a higher pre-operative average HHS in their study group of 42 hip arthroscopies that underwent subsequent THR [21]. Their interpretation was that patients who have undergone and failed a hip arthroscopy may have had less severe disease. The average interval stated here was 22 months [21].

Toennis grade of osteoarthritis before THR was significantly higher in the control group.

In our understanding, this can be conclusively explained by the fact that there was primarily a clear indication for THR for the patients in the control group. The study group consisted of 33 patients that underwent an arthroscopic treatment and required THR at a later stage. This conversion could partially be claimed on borderline indication for the initial hip arthroscopy and on the other hand on the physiological aging process. Apart from the indication of FAI for hip arthroscopy, Toennis grade 0 and 1 is considered as a general limitation [31]. Further degenerative alterations in the preoperative radiograph should be taken into account and restrict indications.

In a cohort study, Bedi et al. focused on the prevalence of HO after hip arthroscopy, the study group included 616 patients, and mean follow-up was 13.2 months. The overall prevalence of HO in the radiographics was stated with 4.7%,

**Table 2** Patient-related outcomes; mHHS, modified Harris Hip Score; THR, total hip replacement

| | mHHS preoperative | mHHS follow-up | $p$ value | Follow-up after THR [months] |
|---|---|---|---|---|
| Study group | 48.0 ± 16.5 | 92.8 ± 9.9 | $p < 0.001$ | 45.6 ± 16.1 |
| Control group | 60.3 ± 12.3 | 93.8 ± 12.7 | $p < 0.001$ | 39.0 ± 8.1 |
| $p$ value | 0.002 | 0.7 | | |

**Table 3** Comparison of osteoarthritis grade and surgical time

| | Toennis grade before THR | Surgical time of THR |
|---|---|---|
| Study group | 1.9 ± 0.7 | 60.1 ± 10.8 |
| Control group | 2.4 ± 0.7 | 61.8 ± 12.8 |
| *p* value | 0.007 | 0.6 |

in most cases with a low level in the Brooker classification. Primarily, the study assessed the influence of indomethacin as a prophylaxis for HO. Through the implementation of indomethacin in the study protocol, the appearance of HO could be significantly reduced to 1.8% [32].

These results show a broad consistency to our findings. The mean interval between hip arthroscopy and THR in our study approximately matches the mean follow-up time of Bedi et al. (16.3 months respectively 13.2 months) [32]. The postoperative treatment after hip arthroscopy in our institution includes the prophylaxis of HO through the prescription of indomethacin and is well established. In consideration of this fact, the missing appearance of HO in our study collective of 33 patients appears statistically reasonable. However, the situation appears different for studies that explored the appearance of HO after THR.

A large-scaled meta-analysis was carried out by Neal et al. in 2002; they included 218 studies and stated an overall incidence of 43% for HO after THR, hereby considering any heterotopic bony formation [33]. The wide-spread variety of classification systems to record HO has to be mentioned in this occasion. Mean follow-up of this meta-analysis was 25 months after THR. The mean follow-up of our study with 45.6 months in the study group and with 39.0 months in the control group exceeds this by far.

The issue of whether a previous hip arthroscopy has a negative influence on the clinical result after a consecutive THR has been discussed in several studies.

Zingg et al. (2012) retrospectively analyzed a group of 18 THR patients who had previously undergone ipsilateral hip arthroscopy. This matched-controlled study showed no significant difference in the used WOMAC Score as a clinical outcome measure [23].

In 2016, Haughom et al. published their results of a retrospective review that included 42 hip arthroscopies that underwent subsequent THR [21]. This study showed the highest number of cases involved so far. Primary outcome measure was the HHS, and no difference was observed in the postoperative result after a mean follow-up of 38 months when they compared the study group with a matched control group.

A research group led by Spencer-Gardner in 2016 compared a THR group of 23 patients with previous hip surgery to a matched control group without a previous intervention [15]. The study group consisted of patients that had previously undergone either a hip arthroscopy or an open surgical hip dislocation because of FAI. The mean interval between previous intervention and the THR was reported with 12 months (3–25) in contrast to our study where the average interval was 16.3 months. There was no significant difference regarding mHHS at FU. The mean FU in their study was 33 months after THR, hencenine  months shorter than in our study. Spencer-Gardner et al. observed increased operative times for the THR procedure after open surgical hip dislocation. In contrast, there was no difference after a previous hip arthroscopy. This finding was explained by the elaborate procedure of hardware removal at the time of THR.

Another matched-controlled study recently published by Perets et al. in 2017 included 35 THR patients that had prior arthroscopic surgery on the same hip for FAI. The study group scored significantly lower values at HHS and Forgotten Joint Score-12 at FU. For example, the study group had an average HHS of 82.6. If this is compared with the results of the other studies mentioned, the values are clearly below those of the publications already mentioned [10, 12]. Visual Analog Score (VAS) for pain was remarkably higher in the study group. Their mean FU was 40 months. To our knowledge, this is the only current study on that issue that suggests adverse effects on the clinical outcome [22].

The studies that showed no influence had mHHS and HHS values above 90 in the arthroscopy group. This value is higher than the value mentioned by Perets et al., so that their statement of a possible negative influence should be viewed critically.

Published in 2017, Charles et al. found no functional or clinical implications for THR after hip arthroscopy for FAI [34]. Their matched case–control study included 39 patients with a mean age of 42.4 years, respectively, 43.8 years in the control group. This means a considerably younger age than in our cohort. Average FU time was 52.4 months in the study group and 50.0 months in the control group and therewith represents the highest value of all studies mentioned above. In contrast, this study focused on surgical outcomes based on inpatient hospital metrics and outpatient complication measures. Surgical time and the appearance of heterotopic ossifications represent the only comparable parameters to our study.

Our study had some limitations:

1) Due to the chosen study design with a demanded minimum two year follow-up after THR and overall five matching criteria, the number of eligible study and control group patients added up to only 33 persons. However, this amount clearly surpassed the calculated sample size of our power analysis. In comparison to the above discussed and in design comparable studies, the amount of 33 patients appears to fit. Without a doubt would a higher quantity of patients unlock the potential of even sharper results and statements.
2) Comparable studies used different and often multiple patient-related outcome measures. A greater variety of assessment scores would be considered desirable.

3) In addition, the limitations of a retrospective analysis have to be mentioned. However, the data were prospectively collected. Hereby, a recall bias could be eliminated and selection bias could be limited to the maximum extent.

## Conclusion

A prior hip arthroscopy for treatment of FAI does not affect clinical outcome after THR. In addition, there was no significant difference regarding operative times and no increased risk of heterotopic ossifications.

### Compliance with ethical standards

**Conflict of interest** The authors declare that there is no conflict of interest.

## References


1. Ganz R, Leunig M, Leunig-Ganz K et al (2008) The etiology of osteoarthritis of the hip: an integrated mechanical concept. Clin Orthop Relat Res 466(2):264–272. https://doi.org/10.1007/s11999-007-0060-z
2. Ganz R, Parvizi J, Beck M et al (2003) Femoroacetabular impingement: a cause for osteoarthritis of the hip. Clin Orthop Relat Res (417): 112–120. https://doi.org/10.1097/01.blo.0000096804.78689.c2
3. Beck M, Kalhor M, Leunig M et al (2005) Hip morphology influences the pattern of damage to the acetabular cartilage: femoroacetabular impingement as a cause of early osteoarthritis of the hip. J Bone Joint Surg (Br) 87(7):1012–1018. https://doi.org/10.1302/0301-620X.87B7.15203
4. Kaya M, Suzuki T, Emori M et al (2016) Hip morphology influences the pattern of articular cartilage damage. Knee Surg Sports Traumatol Arthrosc 24(6):2016–2023. https://doi.org/10.1007/s00167-014-3297-6
5. Magrill ACL, Nakano N, Khanduja V (2017) Historical review of arthroscopic surgery of the hip. Int Orthop 41(10):1983–1994. https://doi.org/10.1007/s00264-017-3454-x
6. Maradit Kremers H, Schilz SR, van Houten HK et al (2017) Trends in utilization and outcomes of hip arthroscopy in the United States between 2005 and 2013. J Arthroplast 32(3):750–755. https://doi.org/10.1016/j.arth.2016.09.004
7. Bozic KJ, Chan V, Valone FH et al (2013) Trends in hip arthroscopy utilization in the United States. J Arthroplast 28(8 **Suppl**):140–143. https://doi.org/10.1016/j.arth.2013.02.039
8. Montgomery SR, Ngo SS, Hobson T et al (2013) Trends and demographics in hip arthroscopy in the United States. Arthroscopy 29(4):661–665. https://doi.org/10.1016/j.arthro.2012.11.005
9. Nakano N, Gohal C, Duong A et al (2018) Outcomes of cartilage repair techniques for chondral injury in the hip-a systematic review. Int Orthop 42(10):2309–2322. https://doi.org/10.1007/s00264-018-3862-6
10. Sariali E, Vandenbulcke F (2018) Clinical outcomes following arthroscopic treatment of femoro-acetabular impingement using a minimal traction approach and an initial capsulotomy. Minimum two year follow-up. Int Orthop 42(11):2549–2554. https://doi.org/10.1007/s00264-018-3904-0
11. Rego PA, Mascarenhas V, Oliveira FS et al (2018) Arthroscopic versus open treatment of cam-type femoro-acetabular impingement: retrospective cohort clinical study. Int Orthop 42(4):791–797. https://doi.org/10.1007/s00264-017-3735-4
12. Kautzner J, Zeman P, Stancak A et al (2018) Hip arthroscopy learning curve: a prospective single-surgeon study. Int Orthop 42(4): 777–782. https://doi.org/10.1007/s00264-017-3666-0
13. Lund B, Mygind-Klavsen B, Grønbech Nielsen T et al (2017) Danish Hip Arthroscopy Registry (DHAR): the outcome of patients with femoroacetabular impingement (FAI). J Hip Preserv Surg 4(2): 170–177. https://doi.org/10.1093/jhps/hnx009
14. Nwachukwu BU, Chang B, Kahlenberg CA et al (2017) Arthroscopic treatment of femoroacetabular impingement in adolescents provides clinically significant outcome improvement. Arthroscopy. https://doi.org/10.1016/j.arthro.2017.04.008
15. Spencer-Gardner L, Dissanayake R, Kalanie A et al (2017) Hip arthroscopy results in improved patient reported outcomes compared to non-operative management of waitlisted patients. J Hip Preserv Surg 4(1):39–44. https://doi.org/10.1093/jhps/hnw051
16. Daivajna S, Bajwa A, Villar R (2015) Outcome of arthroscopy in patients with advanced osteoarthritis of the hip. PLoS One 10(1): e0113970. https://doi.org/10.1371/journal.pone.0113970
17. McCarthy JC, Jarrett BT, Ojeifo O et al (2011) What factors influence long-term survivorship after hip arthroscopy? Clin Orthop Relat Res 469(2):362–371. https://doi.org/10.1007/s11999-010-1559-2
18. Piedade SR, Pinaroli A, Servien E et al (2009) Is previous knee arthroscopy related to worse results in primary total knee arthroplasty? Knee Surg Sports Traumatol Arthrosc 17(4):328–333. https://doi.org/10.1007/s00167-008-0669-9
19. Piedade SR, Pinaroli A, Servien E et al (2013) TKA outcomes after prior bone and soft tissue knee surgery. Knee Surg Sports Traumatol Arthrosc 21(12):2737–2743. https://doi.org/10.1007/s00167-012-2139-7
20. Spencer-Gardner LS, Camp CL, Martin JR et al (2016) Does prior surgery for femoroacetabular impingement compromise hip arthroplasty outcomes? J Arthroplast 31(9):1899–1903. https://doi.org/10.1016/j.arth.2016.02.036
21. Haughom BD, Plummer DR, Hellman MD et al (2016) Does hip arthroscopy affect the outcomes of a subsequent total hip arthroplasty? J Arthroplast 31(7):1516–1518. https://doi.org/10.1016/j.arth.2016.01.008
22. Perets I, Mansor Y, Mu BH et al (2017) Prior arthroscopy leads to inferior outcomes in total hip arthroplasty: a match-controlled study. J Arthroplast. https://doi.org/10.1016/j.arth.2017.06.050
23. Zingg PO, Schallberger A, Rüdiger HA et al (2012) Does previous hip arthroscopy negatively influence the short term clinical result of total hip replacement? Arch Orthop Trauma Surg 132(3):299–303. https://doi.org/10.1007/s00402-011-1352-z
24. Nam D, Maher P, Nath T et al (2014) Does a prior hip arthroscopy affect clinical outcomes in metal-on-metal hip resurfacing arthroplasty? Am J Orthop 43(11):E255–E260
25. Brooker AF, Bowerman JW, Robinson RA et al (1973) Ectopic ossification following total hip replacement. Incidence and a method of classification. J Bone Joint Surg Am 55(8):1629–1632
26. Harris WH (1969) Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 51(4):737–755
27. Byrd JW, Jones KS (2000) Prospective analysis of hip arthroscopy with 2-year follow-up. Arthroscopy 16(6):578–587. https://doi.org/10.1053/jars.2000.7683
28. Söderman P (2000) On the validity of the results from the Swedish National Total Hip Arthroplasty register. Acta Orthop Scand Suppl 71(296):1–33

29. Kemp JL, Collins NJ, Makdissi M et al (2012) Hip arthroscopy for intra-articular pathology: a systematic review of outcomes with and without femoral osteoplasty. Br J Sports Med 46(9):632–643. https://doi.org/10.1136/bjsports-2011-090428
30. Aprato A, Jayasekera N, Villar RN (2012) Does the modified Harris Hip Score reflect patient satisfaction after hip arthroscopy? Am J Sports Med 40(11):2557–2560. https://doi.org/10.1177/0363546512460650
31. Domb BG, Chaharbakhshi EO, Rybalko D et al (2017) Outcomes of hip arthroscopic surgery in patients with Tönnis grade 1 osteoarthritis at a minimum 5-year follow-up: a matched-pair comparison with a Tönnis grade 0 control group. Am J Sports Med 45(10):2294–2302. https://doi.org/10.1177/0363546517706957
32. Bedi A, Zbeda RM, Bueno VF et al (2012) The incidence of heterotopic ossification after hip arthroscopy. Am J Sports Med 40(4):854–863. https://doi.org/10.1177/0363546511434285
33. Neal B, Gray H, MacMahon S et al (2002) Incidence of heterotopic bone formation after major hip surgery. ANZ J Surg 72(11):808–821
34. Charles R, LaTulip S, Goulet JA et al (2017) Previous arthroscopic repair of femoro-acetabular impingement does not affect outcomes of total hip arthroplasty. Int Orthop 41(6):1125–1129. https://doi.org/10.1007/s00264-016-3330-0