



## Original article

# Total hip arthroplasty with accolade/trident through the direct minimally invasive anterior approach without traction table: Learning curve and results after a minimum of 5 years



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## ABSTRACT

**Background:** The direct minimally invasive anterior approach (DMIAA) in total hip arthroplasty (THA) is widely accepted. In our department the DMIAA according to Rachbauer together with the Trident cup and Accolade stem was introduced in 2004. The purpose of the study was to demonstrate the five-year results and to analyze the learning curve of a new introduced approach.

**Patients and methods:** Between July 2004 and May 2006, a consecutive series of 151 THA in 147 patients was retrospectively analyzed. All patients were planned to receive a THA with the Accolade/Trident implant system using the DMIAA without traction table. Clinical and radiographic data, complications and survivorship were documented with a follow-up of at least 5 years.

**Results:** Regarding cup implantation, there were 11 (7.3%) failed intentions to treat due to missing press-fit (8 cases) and acetabular floor perforation (3 cases). No failed intentions to treat occurred during stem implantation. Total implant survival after 5 years follow-up after exclusion of 11 cases with failed intention to treat ( $N=140$ ) was 96.9% (SD 1.4; CI 94.3–99.6). After exclusion of the failed intentions to treat ( $N=140$ ,  $N=4$  in the first 20 cases), there was significant ( $p<0.001$ ) difference between the first 16 implants with a 5 year-survival of 83.2% (SD 8.6; CI 66.4–100) and 95.7% (SD 0.9; CI 93.9–97.5) for the following 124 implants. Radiolucent lines were observed in Gruen zone 1 in 3.3% and in Gruen zone 1 and 2 in 1.1%.

**Discussion:** THA with Accolade/Trident using the DMIAA without traction table according to Rachbauer temporary exposed patients to a higher risk of implant revisions, which was normalized after the first 20 cases. Results of the learning curve are comparable to other techniques using an orthopaedic traction table. After the typical learning curve, the rate of 5 years implant failure is in accordance with the registry data for non-cemented implants. The Accolade stem showed minimal radiographic signs of radiolucency.

**Level of evidence:** IV, retrospective, consecutive case series.

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## 1. Introduction

The direct minimally invasive anterior approach (DMIAA) is the only approach to the hip joint that does not detach tendons either by tenotomy or osteotomy respecting an internervous plane [1]. The DMIAA without traction table has been widely used and established. However, there is still a debate about the best approach regarding, safety, precision, patient outcome (clinical scores) and efficiency. In recent studies the DMIAA showed an advantage in clinical outcome in the first 6 weeks, which seems to level out after that [2,3]. The learning curve of this nowadays popular approach

has been studied in several publications. It has been shown, that the results are worse during the first 20 to 50 cases but not thereafter [4,5]. Together with the introduction of the DMIAA, according to Rachbauer [6] without a traction table in July 2004, the Accolade/Trident TMZF<sup>®</sup> (Stryker Orthopedics; Nahawa NJ, USA) implants were chosen in our department for most of the primary THA.

The Accolade/Trident implants have shown good results using posterolateral, transgluteal and/or anterolateral approaches with a 5-year implant survival ranging from 95% to 98% [7–9]. Unknown is the 5-year survivorship of the Accolade/Trident implant system using the DMIAA without traction table. Therefore, the aim of the study was to analyze the complication and revision rate such as the clinical and radiographic outcome of primary THA with the mentioned implant system through the DMIAA without traction

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table. Furthermore, the learning curve was analyzed including the very first patient treated with this new introduced approach and implant system.

## 2. Methods

One hundred and forty-seven patients undergoing 151 consecutive THA between July 2004 and May 2006 were retrospectively included. All patients were planned to receive Accolade/Trident TMZF® (Stryker Orthopedics; Nahawa NJ, USA) implants through a DMIAA without traction table using the Innsbruck technique, described by Rachbauer [6,10] at our institution with a minimal follow up of five years (mean 81 months (range, 60 to 100)). An Accolade® stem and a Trident® cup together with a 28 mm CoCr or ceramic ball and a highly cross linked polyethylene inlay (Crossfire polyethylene acetabular insert) were used in all patients. The Accolade stem is made of Beta-Titanium alloy and has a tapered wedge design. It is hydroxyapatite coated and in the proximal portion coated with a circumferential plasma spray. Indications for primary THA in patients were to 84% osteoarthritis, 8% avascular necrosis and 8% other indications like secondary to rheumatoid arthritis.

### 2.1. Surgical technique and postoperative treatment protocol

A modified Hueter approach in the supine position was performed [11] The surgical procedure was performed according to Rachbauer et al. [6,10]. All surgeries were performed under a laminar air flow system and 3 doses of cefuroxime 1.5 g in an 8 hours interval starting 30 minutes before incision were applied. Post-operatively, Enoxaparin-Natrium on a daily dose for 6 weeks was administered to all patients except those with anticoagulation for other reason. Weight bearing as tolerated on two crutches was recommended for two weeks and afterwards full weight bearing was encouraged.

### 2.2. Clinical assessment (N = 109 hips)

Demographic parameters, perioperative (during surgery and hospitalisation) and late (after hospital discharge) complications were recorded from patient's charts. Clinical outcome measures, including the Harris Hip Score (HHS) [12], Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [13] and the subjective hip value (SHV) were reviewed. Patients had routine follow-ups at 3 months, 1 year, and 5 years.

### 2.3. Radiographic assessment

On the standardized antero-posterior pelvic X-rays acquired immediately after surgery, cup position in terms of cup inclination and anteversion was determined. The cup anteversion was determined by the method described by Widmer [14]. Cup position was further classified within or outside the safe zone of Lewinnek [15]. A cup was claimed to be within the safe zone if both, inclination and anteversion were within the safe zones. Radiolucent lines around the stem and the cup were assessed in the standardized antero-posterior pelvic X-rays according to the classification of Gruen or Charnley and DeLee respectively at follow-up [16,17].

### 2.4. Statistics

A biostatistician performed the statistical analysis. A statistical software (SPSS Version for Windows) was used for the calculations. Distribution of continuous variables was assessed graphically. Normally distributed data were presented as means  $\pm$  SD or mean and confidence intervals and non-parametric data with medians and ranges. Implant survivorship in the entire series (including the 18

**Table 1**  
Patients and Demographic data.

| Patients and epidemiology              |  |
|--|--|
| Time period                            | July 2004–February 2006  |
| Consecutive series patients/hips (N =) | 147/151  |
| Lost to follow-up                      | 18 patients deceased<br>7 patients abroad<br>1 patient not able to contact                                 |
| Final study cohort patients/hips (N =) | 121/125<br>91 with X-ray and scores<br>30 only WOMAC   |
| Mean follow-up (months)                | 81 $\pm$ 8 (minimal 60 months)   |
| Mean age (years)                       | 64 $\pm$ 13  |
| Mean BMI (kg/m <sup>2</sup> )          | 26 $\pm$ 5   |
| Mean ASA score (points)                | 2.1  |
| Surgeons (N =)                         | 5<br>senior hip consultants: 3 (hips operated n = 128)<br>junior hip consultants: 2 (hips operated n = 23) |

deceased) was assessed using Kaplan–Meier curve analysis with implant revision for any reason as endpoint. All *p*-values were 2-tailed and the alpha level was set at 0.05.

### 2.5. Ethical approval

The presented study was admitted by the responsible investigational ethical review board (KEK-ZH-Nr. 2011-0306) and was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki. All participants gave written informed consent.

## 3. Results

### 3.1. Patients

The study cohort comprised of 147 (151 hips) consecutive patients with a mean age of 64 (range, 20 to 92) years. At the time of final follow-up 18 (12%) patients had died, One (0.7%) patient was not possible to contact and seven (5%) patients migrated out of the country. None of these patients had any complications or revision surgeries based on our knowledge. The detailed patient flowchart and information about the patients and the demographics are depicted in Fig. 1 and Table 1, respectively.

### 3.2. Implant survival (N = 140 hips)

Total implant survival after 5 years follow-up after exclusion of 11 cases with failed intention to treat (N = 140) was 96.9% (SD 1.4; CI 94.3–99.6). The cup and the stem separately had a 5 year survival of 98.2% (SD: 1.1%; 95% CI: 96.1–100%) and 97.6% (SD: 1.2%; 95% CI: 95.3–100%) respectively (Fig. 2).

### 3.3. Complications requiring implant revision: (N = 151)

There were five complications leading to implant exchange. Four of these revisions were performed in our hospital and one patient presented in another hospital and was revised (cup and stem) because of unclear pain but refused to give further information. The detailed information is depicted in Table 2.

### 3.4. Perioperative complications: (N = 151 hips)

There were 11 (7.3%) cases with failed intention to treat regarding cup implantation due to missing pressfit (8 cases) and

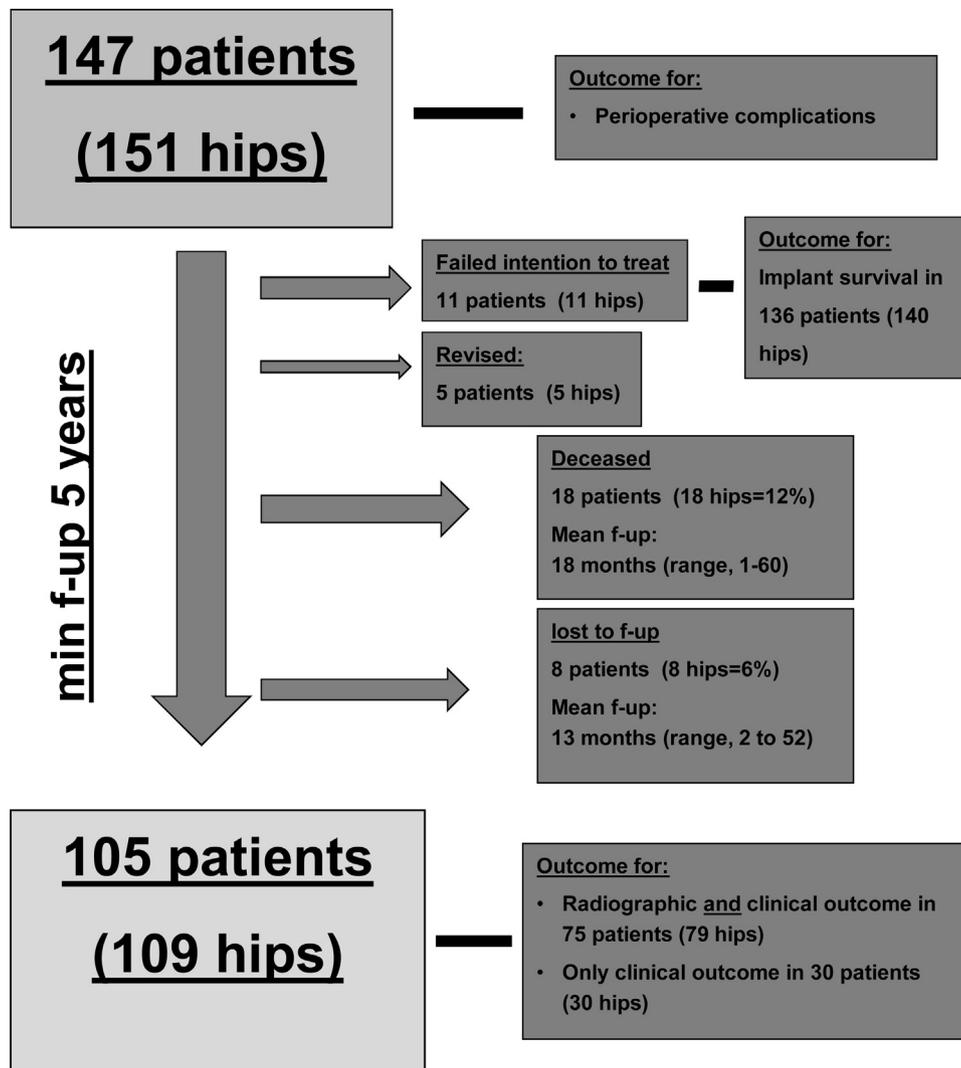


Fig. 1. Patient flowchart with detailed information about the patients during the follow-up period.

Table 2

Detailed information about the complications leading to revision surgery.

|          | Time to revision | 0 days   | 6 weeks                                 | 29 months                         | 30 months   | 45 months                           |
|----------|------------------|--|---|-----------------------------------|---|-------------------------------------|
| Patients |                  | Intraoperative stem perforation leading to stem exchange | Cup revision because of hip instability | Infection with two stage revision | Cup and stem exchange external hospital because of unclear pain | Aseptic stem loosening and revision |
| 1        |                  | 1 <sup>a</sup>   |   |                                   |   |                                     |
| 2        |                  |  | 1                                       |                                   |   |                                     |
| 3        |                  |  |   | 1 <sup>a</sup>                    |   |                                     |
| 4        |                  |  |   |                                   | 1 <sup>a</sup>  |                                     |
| 5        |                  |  |   |                                   |   | 1 <sup>b</sup>                      |

<sup>a</sup> The first 20 cases.

<sup>b</sup> The only patient not operated by the senior consultant alone but supervised by him.

acetabular floor perforation (3 cases). Four of the 11 failed intentions to treat were within the first 20 cases all from the same very experienced senior hip consultant. All 11 cases were treated with another cup; (6 × titanium mesh cementless acetabular component with screws, 2 × cemented low profile cup), In the 3 cases with floor perforation, an antiprotrusion cage was used. No failed intentions to treat occurred during stem implantation. However, there were 5 (3.3%) metaphyseal femoral fractures. Four of them were realized during surgery and treated with a cerclage wiring during index surgery and one was seen in the postoperative radiograph

and treated with restricted weight bearing for six weeks. One of three stem perforations (2%) was treated with revision surgery the same day during a second surgery. One was treated with restricted weight bearing for six weeks since there was only a small cortical interruption. This patient showed a good clinical and radiographic result in the following controls. One other patient was treated with restricted weight bearing for solely 3 weeks since the stem did touch the posterior cortex but there was no interruption of the cortex and the patient showed a good clinical and radiographic result without any special events. There was one early infection

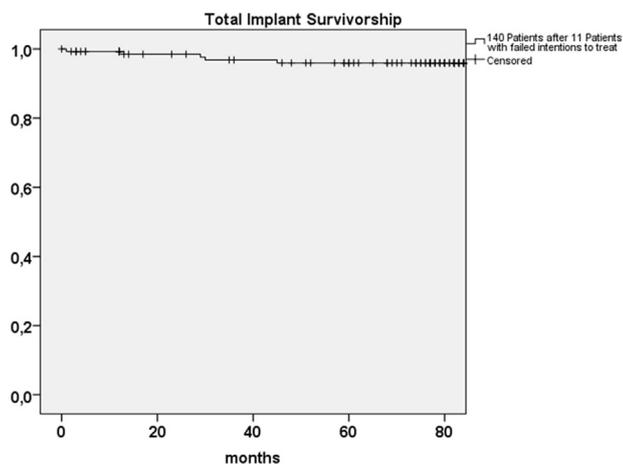


Fig. 2. Survivorship curve with the endpoint implant revision for any reason after exclusion of 11 failed intentions to treat.

with *Staphylococcus aureus* requiring a debridement and a head and inlay exchange 10 days postoperatively. One superficial wound debridement was performed 18 days postoperatively because of a delayed wound healing.

### 3.5. Luxations: (N = 125 hips)

There were three hip dislocations. Two of them had an adequate trauma 18 and 29 months after surgery and were successfully treated with closed reduction. One patient had a cup revision for inadequate cup placement six weeks after index surgery and showed a good result afterwards.

### 3.6. Clinical Outcome (N = 109 hips)

The median value at the 5 year follow-up for the WOMAC (0 best; 10 worst) items pain, stiffness and function were: 0.00 (range: 0–6.5); 0.00 (range: 0–7.5); 0.15 (range: 0–6.8). The difference between values before surgery and at 5 year follow-up was statistically significant for all items ( $p < 0.001$ ).

The mean increase of the HHS was 49 and statistically significant ( $p < 0.001$ ). The median value of SHV at final follow-up was 90 (range: 5–100).

### 3.7. Radiographic Analyzation: (N = 79 hips)

A radiographic evaluation was possible in 79 hips. Localization within the safe zone of Lewinneck were reached in 59% of the cups. Radiolucent lines of  $> 1.5$  mm or more were observed in Gruen zone 1 in 3.3% and in Gruen zone 1 and 2 in 1.1%. No radiolucency around the cup was detected.

### 3.8. Learning curve

The implant survival for the first 20 implants was compared to the following 131 prosthesis for learning curve analysis. 4 of 11 patients with failed intention to treat were within the first 20 cases. After exclusion of the failed intentions to treat ( $N = 140$ ), the learning curve was still significant ( $p < 0.001$ ) with a 5 year survival of 83.2% (SD: 8.6%; 95% CI: 66.4–100) of the first 16 implants and 95.7% (SD: 0.9%; 95% CI: 93.9–97.5%) for the following 124 implants (Fig. 3). A detailed listing of the surgeons and the complications and revisions is depicted in Table 3.

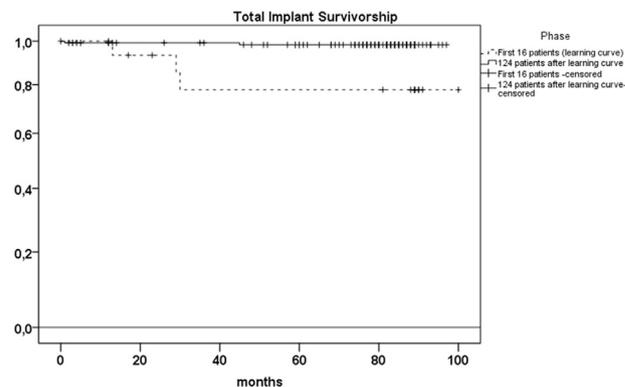


Fig. 3. Comparison of survivorship curves of the first 16 and following 124 THA's after exclusion of 11 failed intentions to treat with endpoint revision for any reason representing a learning curve.

## 4. Discussion

In this case series of 147 patients with 151 primary THA through the DMIAA without traction table using the technique described by Rachbauer, there were good to excellent results after a learning curve of 20 cases. For the anterior minimally invasive surgical approach using a leg holder, a learning curve with a significant increase of the 5 year survival between the first 20 implants and the following 130 from 79% to 97% was suggested [4]. In our study, a similar learning curve for the technique proposed by Rachbauer with a 5 year survival of 83% of the first 16 (4 of the first 20 were failed intentions to treat) implants and 96% for the following 124 implants was shown. In both techniques, there were far more complications in the first 20 cases. This is in line with other learning curve studies for the DMIAA [5,18,19]. Therefore, it has to be acknowledged that the change to the anterior approach to the hip when implanting a THA is associated with a higher complication rate in the first 20 cases. This applies to both techniques, with or without traction table. To minimize these complications, the DMIAA should be trained on cadavers. After feeling comfortable with the anatomy the first 20 cases may ideally be performed together with an experienced hip surgeon using the DMIAA to avoid the typical complications like poor cup placement, overreaming and fracture of the greater trochanter or the metaphysis [4,5,18–21]. However, it can be stated when analyzing our data carefully, that the surgeon with the most experience still had the most complications during the learning curve. The following surgeons, however, could profit from the learning curve of the first surgeon and had fewer complications during their first 20 THA (see Table 3). There were 11 (7.3%) cases with failed intention to treat due to problems with the cup preparation or implantation. The cup positioning was implanted within the safe zone in 59%. These results are comparable to the results of the Versafit/Quadra series with 63% of cups positioned within the safe zone [4] but inferior to a recently published study indicating 73% of conventional implanted cups are in the safe zone [22]. One explanation is that we did not use intraoperative fluoroscopy for the cup positioning regularly at that time. But in our series, there was only one patient who underwent revision surgery due to repetitive dislocation regarding poor cup placement (0.7%). Therefore, our results are in line or even lower than the dislocation rate ranging from 0.6%–2.2% proposed in the literature of THA through the DDA [23–28].

The 5-year implant survival of the Trident cup after exclusion of the failed intentions to treat with 98% is in accordance with the results of a study analyzing results of 20 different non-cemented acetabular components implanted between 1984 and 2004 in the Mayo Clinic [29]. In our series, no radiolucency was seen around the cup at the latest follow-up. A previous study reported radiolucency

**Table 3**

Detailed information about each surgeons complications leading to revision surgery and also intraoperative fractures and stem perforations.

|                                     | THA performed<br>N = | Failed intention to treat cup:<br>N = 151 | THA Revision (any implant):<br>N = 140 | Revision cup:<br>N = 140 | Revision stem:<br>N = 140 | Aseptic stem loosening and revision:<br>N = 140 | Intraoperative metaphyseal fracture:<br>N = 151 | Stem perforation:<br>N = 151 |
|-------------------------------------|----------------------|---|--|--------------------------|---------------------------|---|---|------------------------------|
| Senior Consultant (Head)            | 90                   | 9 (4)                                     | 4 (2)                                  | 3 (2)                    | 3 (2)                     | 0   | 4 (3)   | 1 (1)                        |
| Senior Consultant (vice head)       | 10                   | 1   | 0                                      | 0                        | 0                         | 0   | 0   | 1                            |
| Senior Consultant                   | 22                   | 0   | 0                                      | 0                        | 0                         | 0   | 1   | 0                            |
| Junior Consultant under supervision | 6                    | 0   | 1                                      | 0                        | 1                         | 1   | 0   | 0                            |
| Junior Consultant 1                 | 8                    | 0   | 0                                      | 0                        | 0                         | 0   | 0   | 1                            |
| Junior Consultant 2                 | 15                   | 1   | 0                                      | 0                        | 0                         | 0   | 0   | 0                            |
| Total                               | 151                  | 11  | 5                                      | 3                        | 4                         | 1   | 5   | 3                            |

Numbers in ( ) are during the first 20 cases.

in the zones I and II of Charnley and DeLee of 1.9% and 2.5% in zone III respectively [30]. Those authors combined the Trident cup with the Hipstar cementless stem and used the lateral transgluteal approach. The mean follow-up was only 3.4 years and in their series 2.5% stem loosening have been reported, what is almost 5 times more than in our series with 0.7% after a mean follow-up of 63 months.

Especially for the Accolade stem, there was a study indicating occurrence of radiolucency > 1.5 mm in 3 zones in 10% of the stems after 2 years associated with lower questionnaire scores [31]. In that study of White et al. [31], the 5 year survival with revision for aseptic loosening was 97% (95% CI: 95.6%–98.4%) with a mean follow up was 26.7 months with a range between 0.5 and 60.5 months. Therefore, the results are still in accordance with the Australian registry data. In their series, THA's were implanted through a Hardinge approach by 6 surgeons.

A new prospective multi-center evaluation indicates a 5 year survivorship of 99.4% (95% CI: 96.3%–99.9%) with revision for aseptic loosening and 97.9% (95% CI: 94.6%–99.2%) revision for any reason [7]. These results are in accordance with another earlier study indicating a 5 year survival with revision for any reason of 97.4% [8] and also with our results showing a 5 year survival of 97.6% (95% CI: 95.3–100%) of the Accolade stem. Furthermore, radiolucency of more than 1.5 mm around the stem after 81 months occurred in zone 1 in only 3.3% and in zone 2 in 1.1% and not in other zones. Therefore, the Accolade stem is a reliable implant with good radiographic results after 5 years.

This study has substantial limitations. First of all, it is a retrospective study with the typical problems including not having all data available. Furthermore, some patients were disabled and therefore could not show up for the f-up appointment. Nevertheless, except one single patient, who was not able to trace (he was treated in another hospital) we have information from all patients regarding revision surgery. Therefore, we believe to have a valid case series to make a sincere scientific statement.

## 5. Conclusion

THA with Accolade/Trident using the DMIAA without traction table according to Rachbauer temporary exposed patients to a higher risk of implant revisions, which was normalized after the first 20 cases. Results of the learning curve are comparable to other techniques using an orthopaedic traction table. After the typical learning curve, the rate of 5 years implant failure is in accordance with the registry data for non-cemented implants. The Accolade stem showed minimal radiographic signs of radiolucency.

## Disclosure of interest

The authors declare that they have no competing interest.

## Funding

None.

## Contribution

The first two authors contributed equally to this work. The other authors contributed equally to the manuscript.

## References

- Light TR, Keggi KJ. Anterior approach to hip arthroplasty. *Clin Orthop Relat Res* 1980;255–60.
- Poehling-Monaghan KL, Kamath AF, Taunton MJ, Pagnano MW. Direct anterior versus minimiposterior THA with the same advanced perioperative protocols: surprising early clinical results. *Clin Orthop Relat Res* 2015;473:623–31.
- Meermans G, Konan S, Das R, Volpin A, Haddad FS. The direct anterior approach in total hip arthroplasty: a systematic review of the literature. *Bone Joint J* 2017;99-B:732–40.
- Müller DA, Zingg PO, Dora C. Anterior minimally invasive approach for total hip replacement: five-year survivorship and learning curve. *HIP Int* 2018;24:277–83, <http://dx.doi.org/10.5301/hipint.5000108>.
- de Steiger RN, Lorimer M, Solomon M. What is the learning curve for the anterior approach for total hip arthroplasty? *Clin Orthop Relat Res* 2015;473:3860–6.
- Rachbauer F. Minimally invasive total hip arthroplasty: anterior approach. *Orthopäde* 2006;35:723–4 [726–9].
- Pierce TP, Jauregui JJ, Cherian JJ, Elmallah RDK, Robinson K, Mont MA. Prospective evaluation of short and mid-term outcomes of total hip arthroplasty using the Accolade™ stem. *Hip Int* 2015;25:447–51.
- Lettich T, Tierney MG, Parvizi J, Sharkey PF, Rothman RH. Primary total hip arthroplasty with an uncemented femoral component: two- to seven-year results. *J Arthroplasty* 2007;22:43–6.
- Casper DS, Kim GK, Restrepo C, Parvizi J, Rothman RH. Primary total hip arthroplasty with an uncemented femoral component five- to nine-year results. *J Arthroplasty* 2011;26:838–41.
- Rachbauer F, Nogler M, Mayr E, et al. Minimally invasive single incision anterior approach for total hip arthroplasty – early results. In: Hozack WJ, Krismer M, Nogler M, et al., editors. *Minimally invasive total joint arthroplasty*. Berlin: Springer; 2004. p. 54–9.
- Lesur E, Laude F. Total hip arthroplasty: anterior approach and mini invasive evolution. *EMC-Rhumatologie-Orthopedie* 2004 [44–667–B].
- Harris WH. 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* 1969;51:737–55.
- Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol* 1988;15:1833–40.
- Widmer K-H. A simplified method to determine acetabular cup anteversion from plain radiographs. *J Arthroplasty* 2004;19:387–90.
- Lewinnek GE, Lewis JL, Tarr R, Compere CL, Zimmerman JR. Dislocations after total hip-replacement arthroplasties. *J Bone Joint Surg Am* 1978;60:217–20.
- Gruen TA, McNeice GM, Amstutz HC. Modes of failure of cemented stem-type femoral components: a radiographic analysis of loosening. *Clin Orthop Relat Res* 1979:17–27.

- [17] DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. *Clin Orthop Relat Res* 1976;20:32–32.
- [18] Moskal JT, Capps SG, Scanelli JA. Anterior muscle sparing approach for total hip arthroplasty. *World J Orthop* 2013;4:12–8.
- [19] Hartford JM, Bellino MJ. The learning curve for the direct anterior approach for total hip arthroplasty: a single surgeon's first 500 cases. *Hip Int* 2017;27:483–8.
- [20] D'Arrigo C, Speranza A, Monaco E, Carcangiu A, Ferretti A. Learning curve in tissue sparing total hip replacement: comparison between different approaches. *J Orthop Traumatol* 2009;10:47–54.
- [21] Goytia RN, Jones LC, Hungerford MW. Learning curve for the anterior approach total hip arthroplasty. *J Surg Orthop Adv* 2012;21:78–83.
- [22] Domb BG, Redmond JM, Louis SS, Alden KJ, Daley RJ, LaReau JM, et al. Accuracy of component positioning in 1980 total hip arthroplasties: a comparative analysis by surgical technique and mode of guidance. *J Arthroplasty* 2015;30:2208–18.
- [23] Sariali E, Leonard P, Mamoudy P. Dislocation after total hip arthroplasty using Hueter anterior approach. *J Arthroplasty* 2008;23:266–72.
- [24] Higgins BT, Barlow DR, Heagerty NE, Lin TJ. Anterior vs. posterior approach for total hip arthroplasty: a systematic review and meta-analysis. *Journal of Arthroplasty* 2015;30:419–34.
- [25] Klasan A, Neri T, Oberkircher L, Malcherzyk D, Heyse TJ, Bliemel C. Complications after direct anterior versus Watson-Jones approach in total hip arthroplasty: results from a matched pair analysis on 1408 patients. *BMC Musculoskelet Disord* 2019;1–6, <http://dx.doi.org/10.1186/s12891-019-2463-x>.
- [26] Kennon RE, Keggi JM, Wetmore RS, Zatorski LE, Huo MH, Keggi KJ. Approach. *J Bone Joint Surg Am* 2003;85:39–48.
- [27] Berend KR, Lombardi Jr AV, Seng BE, Adams JB. Enhanced early outcomes with the anterior supine intermuscular approach in primary total hip arthroplasty. *J Bone Joint Surg Am* 2009;91:107–20.
- [28] James CR, Peterson BE, Crim JR, Cook JL, Crist BD. The use of fluoroscopy during direct anterior hip arthroplasty: powerful or misleading? *J Arthroplasty* 2018;33:1775–9, <http://dx.doi.org/10.1016/j.arth.2018.01.040>.
- [29] Kremers HM, Howard JL, Loechler Y, Schleck CD, Harmsen WS, Berry DJ, et al. Comparative long-term survivorship of uncemented acetabular components in revision total hip arthroplasty. *J Bone Joint Surgery* 2012;94 [e82–1–8].
- [30] Lass R, Kolb A, Skrbensky G, Reinisch G, Kubista B, Giurea A, et al. A cementless hip system with a new surface for osseous integration. *Int Orthop* 2014;38:703–9.
- [31] White CA, Carsen S, Rasuli K, Feibel RJ, Kim PR, Beaulé PE. High incidence of migration with poor initial fixation of the Accolade stem. *Clin Orthop Relat Res* 2012;470:410–7.