Changes in Invasiveness and Latent Infection Rate Associated with Switching the Approach in Total Hip Replacement

Clinical Medicine Insights: Arthritis and Musculoskeletal Disorders
Volume 14: 1–4
© The Author(s) 2021
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/11795441211031340
SAGE

Hiroaki Kijima[1], Kenji Tateda[2], Shin Yamada[1], Satoshi Nagoya[2], Masashi Fujii[2], Ima Kosukegawa[2], Tetsuya Kawano[1], Naohisa Miyakoshi[1], Toshihiko Yamashita[2] and Yoichi Shimada[1]

[1]Department of Orthopedic Surgery, Akita University Graduate School of Medicine, Akita, Japan.
[2]Department of Orthopedic Surgery, Sapporo Medical University School of Medicine, Sapporo, Hokkaido, Japan.

ABSTRACT

PURPOSE: Muscle-sparing approaches for total hip replacement (THR) involve learning curves. This study aimed to clarify changes in invasiveness and infection rate with changes in approach.

METHODS: One surgeon changed the approach of THR from Dall's approach (Dall) to anterolateral modified Watson-Jones approach (OCM). Another changed from Dall to a direct anterior approach (DAA). Another 3 surgeons changed from posterolateral approach (PL) to OCM. Subjects were 150 cases, comprising the last 25 cases with conventional approaches and the first 25 cases with new approaches (Dall to OCM: 25 + 25; Dall to DAA: 25 + 25; PL to OCM: 25 + 25 cases). Differences in operative time, bleeding volume, hospital stay, haemoglobin (Hb), white blood cell count, lymphocyte count, creatine kinase (CK) and C-reactive protein (CRP) were investigated.

RESULTS: In the change from Dall to OCM, only hospital stay decreased. In the change from Dall to DAA, hospital stay and CRP decreased, but bleeding volume increased. In the change from PL to OCM, operative time, CRP and CK decreased, but Hb also decreased. Cases with lymphocyte count <1000/μL or lymphocytes comprising <10% of total white blood cells at around day 4 after surgery were defined as latent infection cases. In these cases, operative time was longer, Hb was lower and CK was higher.

CONCLUSION: Introducing muscle-sparing approaches improved many markers of invasiveness, but some items deteriorated. In the early stages of introducing a new approach, choosing cases without obesity and without high muscle volume may reduce the risk of infection.

KEYWORDS: Total hip replacement, surgical approach, learning curve, invasiveness, infection rate

RECEIVED: February 22, 2021. **ACCEPTED:** June 18, 2021.

TYPE: Original Research

FUNDING: The author(s) received no financial support for the research, authorship, and/or publication of this article.

DECLARATION OF CONFLICTING INTERESTS: The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

CORRESPONDING AUTHOR: Hiroaki Kijima, Department of Orthopedic Surgery, Akita University Graduate School of Medicine, 1-1-1 Hondo, Akita 010-8543, Japan. Email: h-kijima@gd5.so-net.ne.jp

Introduction

Various surgical approaches have been reported for total hip replacement (THR).[1-4] In recent years, surgical approaches that do not dissect muscles and tendons have been performed at many facilities to minimize the risks of muscle weakness and dislocation after surgery. In fact, muscle-sparing approaches have been reported to involve less pain and lower dislocation rates.[5] In addition, THR with muscle-sparing surgical approaches resulted in faster postoperative recovery and a reduced hospital stay than that with conventional surgical approaches.[6]

However, different surgeries inevitably entail a learning curve.[7] Thus, at the time of switching from a conventional approach to a muscle-sparing approach, both invasiveness and risk of infection may be increased due to extensions in operative time.

THR is one of the most clinically successful orthopaedic surgeries,[8] but the rate of surgical site infection after THR has not been reduced to zero.[9-12] Once periprosthetic joint infection (PJI) becomes established, those bacteria become difficult to suppress, because the bacteria on the implant surface protect themselves by producing glycoprotein biofilms.[13] Detecting and treating surgical site infections at the time of latent infection before PJI thus become decisive. Moreover, cases in which latent infection is likely to occur need to be avoided, particularly when introducing a new approach.

Evaluating the number and ratio of lymphocytes around postoperative day 4 has been reported as a method for detecting latent infection after spinal instrumental operations.[14,15] Even though the infection rate after THR is also very low, the lymphocyte count around postoperative day 4 can be used to detect the latent infection rate and evaluate changes in infection risk.

This study therefore investigated whether invasiveness or latent infection rate change with the approach change, to facilitate effective selection of cases in the initial stage of introducing new approaches to THR.

Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (https://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (https://us.sagepub.com/en-us/nam/open-access-at-sage).

Materials and Methods

Subjects in this study were 150 patients who underwent THR performed by 5 orthopaedic surgeons in 2 university hospitals between 2015 and 2018. In Facility A, THR was initially performed using Dall's approach (Dall),[16] but 1 surgeon changed from Dall to an anterolateral modified Watson-Jones approach (OCM).[17] Another surgeon changed from Dall to a direct anterior approach (DAA).[18-20] In Facility B, all 3 surgeons changed from a posterolateral approach (PL) to OCM. This study examined 150 cases, including each of the last 25 cases operated under the conventional approach and each of the first 25 cases operated on using the new approach (Dall to OCM: 25 + 25 cases; Dall to DAA: 25 + 25 cases; PL to OCM: 25 + 25 cases).

For these subjects, we measured operative time, intraoperative bleeding volume, postoperative hospital stays and postoperative haemoglobin (Hb), creatine kinase (CK) and C-reactive protein (CRP) levels to investigate whether the degree of surgical invasiveness and degree of postoperative functional recovery varied depending on the approach. Values before and after changing approach were then compared.

In addition, around postoperative day 4, cases with lymphocyte count <1000/μL and comprising <10% of the total white blood cell (WBC) count were reported to show latent infection.[14,15] After that, it was reported that the lymphocyte count around the fourth day after the operation was useful for determining whether or not the latent infection is occurring.[21-23] Furthermore, it has been actively reported recently that the percentage of lymphocyte to total WBC count or the ratio of lymphocyte to neutrophils indicate latent infection.[24-26] We therefore defined the latent infection as those satisfying either cases with lymphocyte count <1000/μL or cases comprising <10% of the total WBC count around postoperative day 4, and investigated how many such latent infection cases existed and whether any change in the proportion of such cases occurred with the approach change; that is, whether the latent infection rate changed. Specifically, postoperative white blood cell count and postoperative lymphocyte count were measured and compared before and after the change in approach.

Results

By changing from the PL approach to the OCM approach, operative time decreased and CK elevation (postoperative CK-preoperative CK) also decreased, but the amount of Hb reduction (preoperative Hb-postoperative Hb) and postoperative CRP level both increased (Table 1). The change from Dall to OCM only significantly reduced postoperative hospital stay, with no significant differences seen in other items (Table 1). On the other hand, when Dall was changed to DAA, postoperative CRP and postoperative hospital stay both decreased, but intraoperative bleeding volume and amount of Hb reduction increased (Table 1).

The frequency of latent infection cases (ie, showing lymphocyte count <1000/μL or <10% of the total WBC count around postoperative day 4) did not increase with any approach change (Table 1). Latent infection cases showed longer operative time, higher postoperative CK and lower postoperative Hb than other cases (Table 2).

There were no actual cases of infection that met the Musculoskeletal Infection Society criteria[27-29] in the subjects of this study.

Discussion

We investigated changes in latent infection rate due to changes in the THR approach for the first time. As a result, latent infection rate was found to remain unchanged even if the surgical approach changed. However, with the introduction of the muscle-sparing approach, some data were discovered to worsen at first.

In recent years, some muscle-sparing approaches have been actively introduced to institutions for the purpose of achieving both an early return to normal life after hip replacement and higher patient satisfaction. However, such approaches have shown clear technical learning curves as compared with conventional approaches.[7] Thus, when switching from a conventional approach to a muscle-sparing approach, the invasiveness and the risk of infection may increase, for example due to the increased operative time.

Postoperative surgical site infection is the worst complication after total joint replacement. Since PJI is often more difficult to treat than surgical site infection after other orthopaedic surgeries, all orthopaedic surgeons need to know whether the infection rate increases when changing the approach for THR. However, no conclusions can be reached until a considerably large number of patients are investigated, because the postoperative infection rate is very low. If a large number of muscle-sparing approaches are performed, techniques for the new approach will also improve, and any effects of introducing the new approach will be overcome, so whether the risk in infection changes in the early stage of introducing a new technique could not be investigated.

We therefore addressed the above difficulties by investigating the proportion of cases considered to be at risk of infection; that is, the latent infection rate, rather than the actual infection rate. This latent infection rate remained unchanged with the change in approach. However, the amount of bleeding, amount of Hb decrease and postoperative CRP all increased in some cases with the introduction of new approaches. Furthermore, cases with lymphocytes <1000/μL or <10% of WBCs around postoperative day 4, which represent latent infection, had longer operation time, higher postoperative CK and lower postoperative Hb than other cases. In other words, patients with high muscle volume who are likely to experience a long operation time and have high postoperative CK should be avoided at the beginning of introducing the new approach, as should patients with low preoperative Hb who are likely to have low postoperative Hb. Avoiding such patients may reduce the latent infection rate, because bleeding volume is increased and postoperative Hb is decreased in the early stage of introducing a new approach.

One of the limitations of this study is that the concept of 'latent infection' has not been established. The latent infection

Table 1. Changes in each item associated with switching the surgical approach.

APPROACH	ITEM	CONVENTIONAL APPROACH	MUSCLE-SPARING APPROACH	*P*-VALUE	CHANGE
PL→OCM	Operative time (min)	142.6	112.1	.0016	↑
	Amount of bleeding (mL)	203	157	.1826	
	CRP (1 d) (mg/dL)	5.01	3.84	.1158	
	CRP (1 wk) (mg/dL)	2.68	4.35	.0192	↑
	Change in Hb value (g/dL) (1 wk)	−1.76	−2.90	.0021	↑
	Change in CK value (IU/L) (3 d)	+225.9	+130.8	.0323	↓
	Postoperative hospital stays (days)	Not available	Not available	–	
	Latent infection rate (%)	12.0	16.0	.6836	
Dall→OCM	Operative time (min)	182.5	172.6	.4398	
	Amount of bleeding (mL)	540	468	.4976	
	CRP (1 d) (mg/dL)	5.07	5.29	.7846	
	CRP (1 wk) (mg/dL)	3.54	3.45	.9233	
	Change in Hb value (g/dL) (1 wk)	−2.38	−2.22	.6046	
	Change in CK value (IU/L) (3 d)	+348.2	+421.7	.4400	
	Postoperative hospital stays (d)	45.5	25.5	<.0001	↓
	Latent infection rate (%)	64.0	62.5	.7628	
Dall→DAA	Operation time (min)	155.4	149.5	.5014	
	Amount of bleeding (mL)	320.5	666.8	.0335	↑
	CRP (1 d) (mg/dL)	5.47	3.75	.0243	↓
	CRP (1 wk) (mg/dL)	3.96	4.11	.8581	
	Change in Hb value (g/dL) (1 wk)	−2.38	−1.78	.0312	↓
	Change in CK value (IU/L) (3 d)	+890.7	+186.3	.3912	
	Postoperative hospital stays (d)	43.0	28.7	<.0001	↓
	Latent infection rate (%)	32.0	48.0	.3690	

Abbreviations: CK, creatine kinase; CRP, C-reactive protein; Hb, haemoglobin.
Change in Hb value: postoperative Hb-preoperative Hb.
Change in CK value: postoperative CK-preoperative CK.

Table 2. Comparison of latent infection cases and non-latent infection cases.

ITEMS	NON-LATENT INFECTION CASES	LATENT INFECTION CASES	*P*-VALUE	CHANGE
Operative time (min)	142.7	169.5	.0007	↑
Amount of bleeding (mL)	366	507	.0880	
CRP (1 d) (mg/dL)	4.47	4.94	.3053	
Postoperative CK (IU/L) (1 d)	419	513	.0382	↑
Postoperative Hb (g/dL) (1 d)	10.13	9.58	.0355	↓
Postoperative hospital stays (d)	38.7	33.8	.1284	

Abbreviations: CK, creatine kinase; CRP, C-reactive protein; Hb, haemoglobin.

defined by criteria used in this study may simply be a possible sign of immune vulnerability. However, in general, reports on various infectious diseases have shown that neutrophils increase compared to lymphocytes as a biological reaction during bacterial infection.[30-32] Therefore, even if bacterial infection is not manifested, an increase in neutrophil-lymphocyte ratio may represent a latent infection rather than a weakened immune system.

The biggest limitation of this study was that the number of subjects was small. However, we were able to evaluate the state immediately after the introduction of the new approach due to this small number of subjects. In addition, even if the number of subjects was small, clinically useful data could be provided by defining latent infection cases rather than actual infection cases. In the future, a similar study using larger data would establish a clearer method for introducing new approaches. This study offers a first step towards such a study with high clinical relevance.

Conclusion

Many markers of surgical invasiveness were improved with the introduction of muscle-sparing approaches, but some items were aggravated in the early stage of introducing such approaches. Introducing a new approach did not worsen the latent infection rate. However, considering the characteristics of latent infection cases, patients with low muscle mass and high preoperative Hb should be selected in the early stages of introducing a new approach.

Authors' Contributions

Hiroaki Kijima and Kenji Tateda contributed to the conception and the design of the study; Hiroaki Kijima, Shin Yamada, and Tetsuya Kawano carried out the analysis and interpretation of data; Hiroaki Kijima, Kenji Tateda, Shin Yamada, Satoshi Nagoya, Masashi Fujii, and Ima Kosukegawa contributed to the collection and assembly of data; Hiroaki Kijima and Shin Yamada wrote prepared the original manuscript draft; Hiroaki Kijima, Tetsuya Kawano, and Naohisa Miyakoshi contributed to the critical revision of the article for important intellectual content and Naohisa Miyakoshi, Toshihiko Yamashita, and Yoichi Shimada were responsible for final approval of the article.

ORCID iD

Hiroaki Kijima https://orcid.org/0000-0003-4939-9545

REFERENCES

1. Galmiche R, Poitras S, Dobransky J, et al. Does surgical approach influence mid- to long-term patient-reported outcomes after primary total hip replacement? A comparison of the 3 main surgical approaches. *Can J Surg*. 2020;63:E181-E189.
2. Miller LE, Gondusky JS, Bhattacharyya S, Kamath AF, Boettner F, Wright J. Does surgical approach affect outcomes in total hip arthroplasty through 90 days of follow-up? A systematic review with meta-analysis. *J Arthroplasty*. 2018;33:1296-1302.
3. Reichert JC, Volkmann MR, Koppmair M, et al. Comparative retrospective study of the direct anterior and transgluteal approaches for primary total hip arthroplasty. *Int Orthop*. 2015;39:2309-2313.
4. Taunton MJ, Trousdale RT, Sierra RJ, Kaufman K, Pagnano MW. John Charnley Award: randomized clinical trial of direct anterior and miniposterior approach THA: which provides better functional recovery? *Clin Orthop Relat Res*. 2018;476:216-229.
5. Goebel S, Steinert AF, Schillinger J, et al. Reduced postoperative pain in total hip arthroplasty after minimal-invasive anterior approach. *Int Orthop*. 2012;36:491-498.
6. Berend KR, Lombardi AV Jr, 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(Suppl 6):107-120.
7. Goytia RN, Jones LC, Hungerford MW. Learning curve for the anterior approach total hip arthroplasty. *Surg Orthop Adv*. 2012;21:78-83.
8. Learmonth ID, Young C, Rorabeck C. The operation of the century: total hip replacement. *Lancet*. 2007;370:1508-1519.
9. Kurtz SM, Lau E, Watson H, Schmier JK, Parvizi J. Economic burden of periprosthetic joint infection in the United States. *J Arthroplasty*. 2012;27(suppl 8):61-65.e1.
10. Kurtz SM, Lau EC, Son MS, Chang ET, Zimmerli W, Parvizi J. Are we winning or losing the battle with periprosthetic joint infection: trends in periprosthetic joint infection and mortality risk for the medicare population? *J Arthroplasty*. 2018;33:3238-3245.
11. Pellegrini A, Legnani C, Meani E. A new perspective on current prosthetic joint infection classifications: introducing topography as a key factor affecting treatment strategy. *Arch Orthop Trauma Surg*. 2019;139:317-322.
12. Chotanaphuti T, Courtney PM, Fram B, et al. Hip and knee section, treatment, algorithm: proceedings of International Consensus on Orthopedic Infections. *J Arthroplasty*. 2019;34:S393-S397.
13. Wildeman P, Tevell S, Eriksson C, et al. Genomic characterization and outcome of prosthetic joint infections caused by *Staphylococcus aureus*. *Sci Rep*. 2020;10:5938.
14. Takahashi J, Shono Y, Hirabayashi H, et al. Usefulness of white blood cell differential for early diagnosis of surgical wound infection following spinal instrumentation surgery. *Spine*. 2006;31:1020-1025.
15. Takahashi J, Ebara S, Kamimura M, et al. Early-phase enhanced inflammatory reaction after spinal instrumentation surgery. *Spine*. 2001;26:1698-1704.
16. Dall D. Exposure of the hip by anterior osteotomy of the greater trochanter. A modified anterolateral approach. *J Bone Joint Surg Br*. 1986;68:382-386.
17. Bertin KC, Röttinger H. Anterolateral mini-incision hip replacement surgery: a modified Watson-Jones approach. *Clin Orthop Relat Res*. 2004;429:248-255.
18. Judet J, Judet R. The use of an artificial femoral head for arthroplasty of the hip joint. *J Bone Joint Surg Br*. 1950;32-B:166-173.
19. Matta JM, Shahrdar C, Ferguson T. Single-incision anterior approach for total hip arthroplasty on an orthopaedic table. *Clin Orthop Relat Res*. 2005;441:1151124.
20. Post ZD, Orozco F, Diaz-Ledezma C, Hozack WJ, Ong A. Direct anterior approach for total hip arthroplasty: indications, technique, and results. *J Am Acad Orthop Surg*. 2014;22:595-603.
21. Iwata E, Shigematsu H, Koizumi M, et al. Lymphopenia and elevated blood C-reactive protein levels at four days postoperatively are useful markers for early detection of surgical site infection following posterior lumbar instrumentation surgery. *Asian Spine J*. 2016;10:220-225.
22. Iwata E, Shigematsu H, Koizumi M, et al. Lymphocyte count at 4 days postoperatively and CRP level at 7 days postoperatively: reliable and useful markers for surgical site infection following instrumented spinal fusion. *Spine*. 2016;41:1173-1178.
23. Iwata E, Shigematsu H, Yamamoto Y, et al. Lymphocyte count at 4 days postoperatively: a reliable screening marker for surgical site infection after posterior lumbar decompression surgery. *Spine*. 2018;43:E1096-E1101.
24. Inose H, Kobayashi Y, Yuasa M, Hirai T, Yoshii T, Okawa A. Procalcitonin and neutrophil lymphocyte ratio after spinal instrumentation surgery. *Spine*. 2019;44:E1356-E1361.
25. Shen CJ, Miao T, Wang ZF, et al. Predictive value of post-operative neutrophil/lymphocyte count ratio for surgical site infection in patients following posterior lumbar spinal surgery. *Int Immunopharmacol*. 2019;74:105705.
26. Inose H, Kobayashi Y, Yuasa M, Hirai T, Yoshii T, Okawa A. Postoperative lymphocyte percentage and neutrophil-lymphocyte ratio are useful markers for the early prediction of surgical site infection in spinal decompression surgery. *J Orthop Surg*. 2020;28:2309499020918402.
27. Parvizi J, Zmistowski B, Berbari EF, et al. New definition for periprosthetic joint infection: from the Workgroup of the musculoskeletal infection society. *Clin Orthop Relat Res*. 2011;469:2992-2994.
28. Osmon DR, Berbari EF, Berendt AR, et al. Executive summary: diagnosis and management of prosthetic joint infection: clinical practice guidelines by the Infectious Diseases Society of America. *Clin Infect Dis*. 2013; 56: 1-10.
29. Parvizi J, Tan TL, Goswami K, et al. The 2018 definition of periprosthetic hip and knee infection: an evidence-based and validated criteria. *J Arthroplasty*. 2018;33:1309-1314.e2.
30. Kazimoglu H, Uysal E, Dokur M, Gunerkan HR. Evaluation of the relationship between neutrophil lymphocyte ratio and the most common bacterial urinary tract infections after transplantation. *Bratisl Lek Listy*. 2019;120:161-165.
31. Marik PE, Stephenson E. The ability of procalcitonin, lactate, white blood cell count and neutrophil-lymphocyte count ratio to predict blood stream infection. Analysis of a large database. *J Crit Care*. 2020;60:135-139.
32. Yildiz Balci S, Kose AO, Yildiz MB, Ozcaliskan S. Complete blood count parameters and neutrophil-to-lymphocyte ratio values as markers for differentiation between systemic infectious and non-infectious uveitis. *Int Ophthalmol*. 2020;40:3033-3041.