Primary Sjögren’s syndrome is not associated with poor outcomes after total hip arthroplasty: a retrospective case–control study with a matched cohort of osteoarthritis patients

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Abstract

Introduction The number of patients with primary Sjögren’s syndrome (PSS) requiring total hip arthroplasty (THA) is expected to increase, but few studies have detailed their outcomes. The purpose of this study was to evaluate a THA cohort of patients with avascular necrosis of the femoral head (ANFH) who had PSS and to compare their outcomes with those of matched patients with osteoarthritis.

Method A case–control study using data from a single-institution arthroplasty registry was performed. Forty-two THAs in 32 patients undergoing THA with a diagnosis of PSS were identified and were matched with 84 THAs in 64 patients with osteoarthritis (1:2 ratio). Functional and health-related quality of life (QoL) evaluations were performed, and complications were recorded at the last follow-up. Logistic regression was used to determine factors associated with reaching the transfusion trigger of hemoglobin < 8 g/dL (TT8) in PSS patients.

Results After a mean 5-year follow-up, both cohorts had similar hip function and health-related QoL outcomes. The incision complications and reaching TT8 were greater in the PSS group. No differences were observed in the rate of 90-day readmission, reoperation, or overall revision. By multivariate analysis, the influencing factors for reaching TT8 in PSS patients were lower preoperative hemoglobin (OR = 0.842, 95% CI [0.741–0.958], P < 0.05).

Conclusion Our study demonstrated PSS patients who received THA due to ANFH could achieve clinical outcomes similar to those of non-PSS patients. Improving preoperative Hb level can reduce the risk of transfusion.

Key Points

• THA significantly improved hip function and health-related quality of life in PSS patients with osteonecrosis of the femoral head.
• Patients with PSS were more likely to reach the transfusion trigger and higher rates of incision complications after THA.
• Improving preoperative Hb level can reduce the risk of transfusion for PSS patients who underwent THA.

Keywords Outcomes · Postoperative transfusion · Primary Sjögren’s syndrome · Total hip arthroplasty
immunosuppressants are the most common treatments for PSS [1]. A longer disease course and the use of glucocorticoids increase the risk of avascular necrosis of the femoral head (ANFH) in these patients.

Total hip arthroplasty (THA) is the standard treatment for end-stage ANFH and significantly improves hip function and quality of life (QoL) in rheumatic diseases such as systemic lupus erythematosus (SLE) and rheumatoid arthritis (RA), although its complications and long-term survival are controversial [4–7]. There is a lack of studies on the clinical outcomes of THA in patients with PSS. A previous study showed that Sjögren’s syndrome (SS) was not associated with implant infection, revision surgery, or mortality post-THA; however, SS patients had a high rate of blood transfusion after THA [8]. Understanding the THA outcomes of PSS will help provide effective evidence for treating osteonecrosis in this young and mostly immuno-suppressed patient group. In addition, previous studies have not distinguished between PSS and secondary SS and have lacked control subjects.

In this study, we examined a large single-center database to evaluate whether PSS patients who received THA due to ANFH could achieve clinical outcomes similar to those of non-PSS patients and to determine the risk factors for blood transfusion by case-matching patients with hip osteoarthritis who had no history of inflammatory disease at the time of surgery. Specifically, we evaluated the following: (1) hip function, (2) quality of life, (3) complications, and (4) influencing factors of the transfusion trigger.

Materials and methods

Participants

In this retrospective study, patients diagnosed with PSS and ANFH were screened from the hip replacement database. Patients who had other rheumatic immune system diseases or received revision surgery or emergency surgery for fracture were excluded. From January 2002 to December 2020, 36 patients with PSS underwent THA due to ANFH. Four of them were lost to follow-up and could not be contacted by telephone. The final study cohort included 42 THAs in 32 patients. All patients met the 2002 or 2016 diagnostic criteria for PSS [9, 10], and their medical records all contained the record of the diagnosis made by the rheumatologists in our hospital. All 32 patients (30 females and 2 males) were followed up for more than 1 year, and the average follow-up duration was 5.05 ± 3.99 years (range: 1.2–19.6 years). Three patients underwent simultaneous bilateral THAs, and seven patients underwent staged bilateral THAs; the total number of operations was 39.

To reduce the effects of selection bias and potential confounders, a matched comparison cohort was subsequently created as a control group. The control group was matched to the PSS group at a ratio of 1:2 from the database of 10,378 THAs. The cohorts were matched for age (within 1 year), sex, bilateral or staged surgery, American Society of Anesthesiologists (ASA) score (within 1 point), and surgical data (within 1 year). This process yielded 84 THAs in 64 patients who underwent primary THA for hip osteoarthritis, of which six patients underwent simultaneous bilateral arthroplasty and fourteen patients underwent staged bilateral THAs. The outcome of the patients was not known at the time of matching. Informed consent was obtained from all patients prior to inclusion in the study. The study protocol was approved by the local ethics committee.

A group of surgeons with high surgical volume who underwent the same surgical training completed the procedure. All patients had a posterolateral approach and cementless fixation. The acetabular components included the Pinnacle (DePuy Orthopaedics, Warsaw, IN, USA), R3 (Smith & Nephew, Memphis, TN, USA), Tritanium (Stryker, Mahwah, NJ, USA), and trabecular metal (Zimmer, Warsaw, IN, USA) components. The femoral prostheses included the Corail Stem (DePuy Orthopedics, Warsaw, IN, USA), Synergy (Smith & Nephew, Memphis, TN, USA), and Accolade II (Stryker, Mahwah, NJ, USA) prostheses.

They were also similar in terms of perioperative analgesia, infection prevention, thromboprophylaxis protocol, and rehabilitation. Routine follow-up was at 4 weeks, 3 months, 6 months, and 12 months and then annually thereafter. Patients who did not return for regularly scheduled visits were contacted by telephone.

Data collection

The demographic data included age, sex, BMI, ASA score, operation time, and length of hospital stay. All data were obtained from the electronic medical record system. For patients in the PSS group, the age at diagnosis of PSS and the time from PSS diagnosis to surgery were also recorded.

The Hip Disability and Osteoarthritis Outcome Score (HOOS), a patient-reported outcome measure (PROM), was used to evaluate the hip function [11]. Pain was evaluated using the visual analog scale (VAS) pain score [12]. QoL was assessed using the EuroQol 5-Dimensions (EQ-5D) and the EQ-VAS [13, 14]. The patients were explained these scales in detail before they performed the PROM.

Postoperative complications were also recorded through the electronic medical record system and each follow-up record. Surgical complications included wound complications (delayed wound healing, exudation, hematoma,
superficial surgical site infection, deep surgical site infection), vascular and nerve injury, high fever (temperature > 39 °C except from infection), hypokalemia, hypocalcemia, vomiting, dislocation, periprosthetic infection (PJI), and pulmonary and urinary tract infections within 30 days after surgery. Deep-vein thrombosis and pulmonary embolism were diagnosed by color Doppler ultrasound of the lower-extremity vessels and computed tomography angiography of the pulmonary arteries in patients with related symptoms within 90 days after surgery. Revision surgery was defined as the replacement of any prosthetic component for any reason. Reoperation and 90-day readmission related to the hip joint or complications were also recorded.

The hematological indicators were collected and the total estimated blood loss was calculated by a formula described in previous studies [15, 16]. The decision on blood transfusion greatly depended on the clinician and more stringent thresholds for transfusion of 7–8 g/dL of Hb have been recommended [17, 18]. For the purposes of this study, we used the conservative Hb level of 8 g/dL as the transfusion trigger (TT8). The EULAR Sjögren’s Syndrome Patient Reported Index (ESSPRI) was used to evaluate the preoperative PSS activity [19]. The kidney involvement (renal tubular acidosis, renal tubular injury, renal interstitial lesions, etc.), liver involvement (primary biliary cholangitis, autoimmune hepatitis, abnormal liver function, etc.), and lung involvement (interstitial lung disease, multiple pulmonary bullae, pulmonary nodular amyloidosis, etc.) in PSS patients were also recorded. The preoperative hematological markers useful for diagnosis, activity evaluation indicators, and the preoperative use of glucocorticoids and disease-modifying antirheumatic drugs (DMARDs) were recorded.

Statistical analysis

Statistical analyses were performed with SPSS version 23 (SPSS, Chicago, IL). All data are reported using standard descriptive statistics, including mean ± SD for continuous variables and count for categorical variables. Categorical variables were compared using the chi-squared test or Fisher’s exact test. Continuous variables were compared by the two-sample t-test or the Wilcoxon rank-sum test. Predictors that were found statistically significant in the univariate analysis were included in the multivariate analysis to estimate odds ratios and 95% confidence intervals of reaching the transfusion trigger. The final models for multivariate analysis were chosen using enter selection method. BMI and preop Hb were forced into the final model during the model selection. A P value < 0.05 was considered to be statistically significant.

Results

Demographic characteristics

There was no difference in age, gender, BMI, or ASA score between the two groups (P > 0.05). The average follow-up durations were 5.05 ± 3.99 years for the PSS group and 5.02 ± 4.16 years for the control group (P > 0.05). The operation time was 143.60 ± 27.19 min in the PSS group and 148.13 ± 32.12 min in the control group (P > 0.05). The two groups had no difference in the average length of hospital stay (P > 0.05). See Table 1 for details.

Hip function and health-related quality of life outcomes

Patients in both groups had similar hip function scores before surgery, and there were no differences in the individual components of the HOOS or the total HOOS at the final follow-up. VAS scores improved in both groups, with VAS scores of 1.51 ± 0.94 versus 1.45 ± 1.17 in the PSS and control groups, respectively, at the final follow-up (P > 0.05). In terms of QoL outcomes, patients with PSS had a worse preoperative EQ-VAS than controls (P < 0.05). Postoperatively, there were no differences in any component or in the total EQ-VAS score between the two groups. The satisfaction scores of patients in both groups were 94.72 ± 3.96 versus 95.14 ± 4.22, respectively (P > 0.05). Four patients with PSS still required walking aids at the last follow-up; however, none of these was related to pain or functional decline of the hip joint. See Tables 2 and 3 for details.

Complications and reoperation

Incision complications occurred in four patients in the PSS group, including two cases of delayed wound healing,
Preoperative

|                      | PSS group | Control group | P value |
|----------------------|-----------|---------------|---------|
| EQ-mobility          | 3.23 ± 1.20 | 2.88 ± 1.07  | 0.116   |
| EQ-self care         | 3.21 ± 1.45 | 2.88 ± 1.35  | 0.240   |
| EQ-usual activity    | 3.74 ± 0.88 | 3.76 ± 0.90  | 0.942   |
| EQ-pain              | 3.87 ± 0.77 | 3.77 ± 1.14  | 0.613   |
| EQ-anxiety           | 2.79 ± 1.36 | 3.00 ± 1.31  | 0.432   |
| EQ-scores            | 0.18 ± 0.21 | 0.22 ± 0.20  | 0.250   |
| EQ-VAS               | 55.82 ± 12.62 | 61.87 ± 15.48 | 0.037   |

Postoperative

|                      | PSS group | Control group | P value |
|----------------------|-----------|---------------|---------|
| EQ-mobility          | 1.85 ± 0.63 | 1.60 ± 0.69  | 0.067   |
| EQ-self care         | 1.28 ± 0.46 | 1.22 ± 0.42  | 0.448   |
| EQ-usual activity    | 1.33 ± 0.53 | 1.45 ± 0.53  | 0.267   |
| EQ-pain              | 1.33 ± 0.58 | 1.29 ± 0.49  | 0.706   |
| EQ-anxiety           | 1.54 ± 0.64 | 1.71 ± 0.81  | 0.264   |
| EQ-scores            | 0.86 ± 0.085 | 0.87 ± 0.084 | 0.719   |
| EQ-VAS               | 76.18 ± 13.07 | 80.14 ± 14.36 | 0.150   |
| Walking aid (Y/N)    | 4/28       | 4/60          | 0.434   |
| Patient satisfaction | 94.72 ± 3.96 | 95.14 ± 4.22 | 0.603   |

Abbreviations: EQ, European Quality of Life Scale; VAS, visual analog scale

The two groups had no difference in preoperative Hb or HCT. The patients in the PSS group had lower Hb on the first postoperative day and lower HCT on the third postoperative day (P < 0.05). The two groups had no difference in the total blood loss. However, more patients in the PSS group than in the control group reached the transfusion trigger (P < 0.05). Among the univariate factors, the predictors associated with reaching TT8 in PSS patients included low

Changes. Pulmonary infection occurred in four patients in the PSS group including two with preoperative pulmonary interstitial fibrosis and in two patients in the control group. Among the patients with postoperative pulmonary infection, two PSS patients with preoperative pulmonary interstitial fibrosis were cured after antibiotic treatment. In the PSS group, sixteen patients reached the transfusion trigger (P < 0.05). Postoperative dislocation occurred in two patients in the PSS group during hospitalization. One of these patients had anterior dislocation caused by excessive posterior extension, and the other patient had posterior dislocation. The two patients did not have dislocation after reduction and brace fixation. The two groups had no significant differences in other complications, and none of the patients in either group had 90-day readmission, revision, or reoperation. See Table 4 for details.

Hematological outcomes and risk of reaching the transfusion trigger

The two groups had no difference in preoperative Hb or HCT. The patients in the PSS group had lower Hb on the first postoperative day and lower HCT on the third postoperative day (P < 0.05). The two groups had no difference in the total blood loss. However, more patients in the PSS group than in the control group reached the transfusion trigger (P < 0.05). Among the univariate factors, the predictors associated with reaching TT8 in PSS patients included low

Table 4 Perioperative complications. Values are Y/N unless otherwise specified

|                      | PSS group | Control group | P value |
|----------------------|-----------|---------------|---------|
| Wound complications (n) | 4/38   | 1/83          | 0.042   |
| Pulmonary infection (n) | 4/35   | 2/76          | 0.177   |
| Urinary tract infection (n) | 3/36   | 1/77          | 0.300   |
| DVT (n)               | 0/39     | 0/78          | 1.000   |
| PE (n)                | 0/39     | 0/78          | 1.000   |
| Hb < 80 g/L (n)       | 16/23    | 14/64         | 0.013   |
| Hypokalemia (n)       | 15/24    | 20/58         | 0.199   |
| Hypocalcemia (n)      | 5/34     | 6/72          | 0.503   |
| High fever (n)        | 5/34     | 6/72          | 0.503   |
| Vomiting (n)          | 4/35     | 7/71          | 0.999   |
| Neurovascular events (n) | 0/42   | 0/84          | 1.000   |
| Periprosthetic infection (n) | 0/42   | 0/84          | 1.000   |
| Periprosthetic fracture (n) | 0/42   | 0/84          | 1.000   |
| Dislocation (n)       | 2/40     | 0/84          | 0.109   |
| 90-day readmission (n) | 0/42     | 0/84          | 1.000   |
| Reoperation (n)       | 0/42     | 0/84          | 1.000   |

Abbreviations: DVT deep vein thrombosis, PE pulmonary embolism, Hb hemoglobin

one case of incision exudation, and one case of redness and swelling around the incision. Delayed wound healing occurred in one patient in the control group. All patients with incision complications improved after repeated dressing
BMI ($P=0.043$) and low preoperative Hb ($P<0.001$). By multivariate analysis, preoperative Hb was statistically significant predictors of reaching TT8. A 1-g/dL increase in hemoglobin was associated with decreased risk of reaching transfusion trigger ($OR=0.842$, 95% CI $[0.741–0.958]$, $P<0.05$). See Tables 5 and 6 and Supplementary Table 1 for details.

### Discussion

With the gradual increase in the number of PSS survivors receiving corticosteroids and immunosuppressants [1, 2], the number of patients requiring THA will increase steadily. It is important to assess whether these patients can achieve good post-THA outcomes without suffering a higher risk of complications. To the best of our knowledge, this is the first study to assess clinical outcomes in patients with PSS compared to a matched group of control patients. It was found that PSS patients achieved post-THA clinical outcomes similar to those of osteoarthritis patients despite their differences in postoperative incision complications and reaching transfusion trigger. In addition, multivariate analysis showed that low preoperative Hb was risk factors for blood transfusion in PSS patients who underwent THA.

The results showed that hip arthroplasty improved hip function and QoL in patients with PSS to the same extent as it did in patients with osteoarthritis. Similar improvements in functional outcomes have also been found in RA and SLE. In a study of SLE patients who underwent THA, the Harris hip score of the 13 SLE patients (19 THAs) increased from an average of 65.3 points to 94.9 points at the latest follow-up, which was not different from that in the matched non-SLE control group [20]. Wakabayashi et al. [21] performed THA in 28 RA patients and found that the average postoperative 5-year hip score improved satisfactorily. However, Morohama et al. [22] found, in the post-THA follow-up of 77 RA patients, that although THA improved clinical outcomes in damaged hips and had a positive secondary systemic effect on RA disease activity, it did not have a continuously good effect on the measures of health-related QoL. In our case, although PSS patients had poor preoperative EQ-VAS scores, they achieved a postoperative QoL similar to that of osteoarthritis patients.

Patients with inflammatory arthritis have a higher incidence of post-THA complications [23, 24]. In our study, the
PSS patients had a higher incidence of incision complications after THA, but none of them had thrombosis, infection, or revision surgery. Singh et al. [8] found although SS was associated with significantly higher odds of discharge to a rehabilitation/inpatient facility after THA, SS was not associated with implant infection or revision or mortality. Chen et al. [25] found that the risk of prosthetic joint infection (PJI) in SLE patients was 2.74 times than in non-SLE patients who underwent THA. Immune diseases are typically treated with corticosteroids or other immunosuppressants, both of which are thought to increase the incidence of PJI [26]. In addition, patients with SLE are more susceptible to major infections, and those patients with prosthetic hip joints may have a risk of hematogenous spread [27, 28]. 

PSS patients are susceptible to infection. According to Lin et al. [29], the mortality rate of SS patients was 3.1%, most of which was from pulmonary infection or other infection. In our study, although the number of patients with pulmonary infection was not significantly different from the number of patients with urinary tract infection in the PSS group, these two rates were both greater than those in the control group.

Blood transfusion is not a benign treatment but may increase the risk of viral transmission and cause acute hemolytic transfusion reactions, circulatory overload, and PJI [30]. However, blood transfusion is done based on many factors and, to a large extent, depends on the judgment of the clinician [17, 18]. Therefore, we applied a transfusion trigger to eliminate this bias, and we found that more PSS patients reached the transfusion trigger. Low preoperative Hb was the independent risk factor for blood transfusion in PSS patients. The low preoperative Hb in PSS patients might have been caused by various factors. The circulatory system is one of the systems commonly affected by PSS, mainly because the presence of a variety of autoantibodies in the serum of PSS patients can cause a decrease in Hb [31, 32]. Normocytic normochromic anemia occurs in approximately 20% of PSS patients. Long-term use of immunosuppressants can cause bone marrow suppression, resulting in reduced blood cell populations [33]. Bini et al. [18] also found that lower preoperative Hb was associated with a higher risk of blood transfusion in RA patients after total joint arthroplasty. The systematic review conducted by Wilson et al. [34] showed that erythropoietin and iron treatment of RA patients who were about to undergo arthroplasty significantly reduced their need for transfusion. These results suggest that the optimization of preoperative Hb can reduce the risk of blood transfusion.

The present study had several limitations, and our findings should be interpreted with them in mind. First, although we used cohort matching, potential bias still existed due to the inherent limitations of this retrospective study. Second, due to the limited sample size, differences in rare complications could not be identified, and additional variables (e.g., the use of tranexamic acid, the types of disease-modifying antirheumatic drugs, and more details on autoantibodies and the dose of glucocorticoids) could not be included in the multivariate analysis. However, the incidence of PSS is lower compared to other rheumatic diseases such as SLE and RA; hence, the lower incidence means that the potential number of patients performing THA is even lower. Third, the different surgeons used different implants from different manufacturers, though we believe that this diverse setting can more truthfully reflect the real-world results in the community and make the results more generalizable. Fourth, although the hip function of all patients was similar at the last follow-up and no reoperation was performed, a comparison of imaging data, such as loosening and heterotopic ossification, was lacking. The reason is that some patients could not come to the hospital for X-rays due to the restrictions for the COVID-19 epidemic.

Despite these shortcomings, given the limited amount of matched comparative data on this particular patient population, we believe this study is a valuable addition to the literature. It was found that THA significantly improved hip function and QoL in this young, immunosuppressed patient population compared with the general population. Patients with PSS were more likely to reach the transfusion trigger and higher rates of incision complications, but there were no differences in other complications, readmissions, or reoperations. According to our results, rheumatologists and orthopedist should not feel reluctant to suggest THA for PSS patients with femoral head necrosis because of concerns about outcomes or potential medical complications. This information can also be used to help counsel patients with PSS who are considering hip arthroplasty. Improving preoperative Hb level can reduce the risk of transfusion. Future prospective multicenter studies with large samples are needed to evaluate the long-term effects of THA in patients with PSS.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10067-022-06256-2.

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Declarations

Ethics approval and consent to participate All procedures involving human participants carried out in the studies were in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Helsinki Declaration and its later amendments or
comparable ethical standards. This study was approved by the Peking Union Medical College Hospital Institutional Review Board, and the informed consent was obtained from each participant before the enrollment of this study.

Disclosures None.

References

1. Ramos-Casals M, Brito-Zeron P, Siso-Almirall A, Bosch X (2012) Primary Sjogren syndrome. BMJ 344:e3821
2. Mariette X, Criswell LA (2018) Primary Sjogren’s syndrome. N Engl J Med 378(10):931–939
3. Bowman SJ (2018) Primary Sjogren’s syndrome. Lupus 27(1_suppl):32–35
4. Koressell JE, Perez BA, DeAngelis RD, Kerbel YE, Sheth NP, Nelson CL (2022) Prolonged impact of insurance payor and socioeconomic status in total hip arthroplasty outcomes: results from a high volume tertiary care center. J Arthroplasty 37:S434–S438. https://doi.org/10.1016/j.arth.2022.03.018
5. Toci GR, Magnuson JA, DeSimone CA, Stambough JB, Star AM, Saxena A (2022) A systematic review and meta-analysis of non-database comparative studies on cemented versus uncemented femoral stems in primary elective total hip arthroplasty. J Arthroplasty. https://doi.org/10.1016/j.arth.2022.03.086
6. Merayo-Chalico J, Gonzalez-Contreras M, Ortiz-Hernandez R, Alcocer-Varela J, Marcial D, Gomez-Martin D (2017) Total hip arthroplasty outcomes: an 18-year experience in a single center: is systemic lupus erythematosus a potential risk factor for adverse outcomes? J Arthroplasty 32(11):3462–3467
7. Issa K, Naziri Q, Rasquinha VJ, Tateossian T, Kapadia BH, Mont MA (2013) Outcomes of primary total hip arthroplasty in systemic lupus erythematosus with a proximally-coated cementless stem. J Arthroplasty 28(9):1663–1666
8. Singh JA, Cleveland JD (2020) Sjogren’s syndrome is associated with higher rate of non-home discharge after primary hip arthroplasty and higher transfusion rates after primary hip or knee arthroplasty: a U.S. cohort study. BMC Musculoskeletal Disord 21(1):492
9. Vitali C, Bombardieri S, Jonsson R, Moutsopoulos HM, Alexander EL, Carsons SE, Daniels TE, Fox PC, Fox RI, Kassan SS, Pillemer SR, Talal N, Weisman MH (2002) Classification criteria for Sjogren’s syndrome: a revised version of the European criteria proposed by the American-European Consensus Group. Ann Rheum Dis 61(6):554–558
10. Shiboski CH, Shiboski SC, Seror R, Criswell LA, Labetoulle M, Lietman TM, Rasmussen A, Scofield H, Vitali C, Bowman SJ, Mariette X (2017) 2016 American College of Rheumatology/European League Against Rheumatism classification criteria for primary Sjogren’s syndrome: a consensus and data-driven methodology involving three international patient cohorts. Ann Rheum Dis 76(1):9–16
11. Nilsdotter A, Bremander A (2011) Measures of hip function and symptoms: Harris Hip Score (HHS), Hip Disability and Osteoarthritis Outcome Score (HOOS), Oxford Hip Score (OHS), Lequesne Index of Severity for Osteoarthritides of the Hip (LISOH), and American Academy of Orthopedic Surgeons (AAOS) hip and knee questionnaire. Arthritis Care Res (Hoboken) 63(Suppl 11):S200–7
12. Li S, Lu Q, Guo X, Zhang M, Miao Z, Luo D, Liu P (2020) Intravenous combined with topical tranexamic acid administration has no additional benefits compared with intravenous administration alone in high tibial osteotomy: a retrospective case-control study. Orthop Surg 12(2):515–523
13. van Hout BA, Shaw JW (2021) Mapping EQ-5D-3L to EQ-5D-5L. Value Health 24(9):1285–1293
14. Tan RL, Yang Z, Igarashi A, Herdman M, Luo N (2021) How do respondents interpret and view the EQ-VAS? A qualitative study of three Asian populations. Patient 14(2):283–293
15. Palanisamy JV, Das S, Moon KH, Kim DH, Kim TK (2018) Intravenous tranexamic acid reduces postoperative blood loss after high tibial osteotomy. Clin Orthop Relat Res 476(11):2148–2154
16. Nadler SB, Hidalgo JH, Bloch T (1962) Prediction of blood volume in normal human adults. Surgery 51(2):224–232
17. Carson JL, Stanworth SJ, Roubinian N, Ferguson DA, Triulzi D, Dorec C, Hebert PC (2016) Transfusion thresholds and other strategies for guiding allogeneic red blood cell transfusion. Cochrane Database Syst Rev 10:CD002042
18. Bini SA, Darbinian JA, Brox WT, Khatod M (2018) Risk factors for reaching the post-operative transfusion trigger in a community primary total knee arthroplasty population. J Arthroplasty 33(3):711–717
19. Seror R, Ravaud P, Mariette X, Bootma H, Theander E, Hansen A, Ramos-Casals M, Dorner T, Bombardieri S, Hachulla E, Brun JG, Kruize AA, Prapatronik S, Tomsic M, Gottenberg JE, Devauchelle V, Devita S, Vollenweider C, Mandt T, Tzioufas A, Carsons S, Saraus’s A, Sutcliffe N, Vitali C, Bowman SJ (2011) EULAR Sjogren’s Syndrome Patient Reported Index (ESSPRI): development of a consensus patient index for primary Sjogren’s syndrome. Ann Rheum Dis 70(6):968–972
20. Woo MS, Kang JS, Moon KH (2014) Outcome of total hip arthroplasty for avascular necrosis of the femoral head in systemic lupus erythematosus. J Arthroplasty 29(12):2267–2270
21. Wakabayashi H, Hasegawa M, Yoshida K, Nishioka K, Sudo A (2013) Hip score and disease activity correlation in patients with rheumatoid arthritis after total hip arthroplasty. Int Orthop 37(7):1245–1250
22. Momohara S, Inoue E, Ikari K, Yano K, Tokita A, Suzuki T, Sakuma Y, Hiroshima R, Kawakami K, Masuda I, Iwamoto T, Taniguchi A, Yamanaka H (2011) Efficacy of total joint arthroplasty in patients with established rheumatoid arthritis: improved longitudinal effects on disease activity but not on health-related quality of life. Mod Rheumatol 21(5):476–481
23. Richardson SS, Kahlenberg CA, Goodman SM, Russell LA, Sculco TP, Sculco PK, Figgie MP (2019) Inflammatory arthritis is a risk factor for multiple complications after total hip arthroplasty: a population-based comparative study of 68,346 patients. J Arthroplasty 34(6):1150-1154.e2
24. Goodman SM, Figgie M (2013) Lower extremity arthroplasty in patients with inflammatory arthritis: preoperative and perioperative management. J Am Acad Orthop Surg 21(6):355–363
25. Chen CH, Chen TH, Lin YS, Chen DW, Sun CC, Kuo LT, Shao SC (2020) The impact of systemic lupus erythematosus on the risk of infection after total hip arthroplasty: a nationwide population-based matched cohort study. Arthritis Res Ther 22(1):214
26. Mourao AF, Amaral M, Caetano-Lopes J, Isenberg DA (2009) An analysis of joint replacement in patients with systemic lupus erythematosus. Lupus 18(14):1298–1302
27. Tektonidou MG, Wang Z, Dasgupta A, Ward MM (2015) Burden of serious infections in adults with systemic lupus erythematosus: a national population-based study, 1996–2011. Arthritis Care Res (Hoboken) 67(8):1078–85
28. Goldblatt F, Chambers S, Rahman A, Isenberg DA (2009) Serious infections in British patients with systemic lupus erythematosus: hospitalisations and mortality. Lupus 18(8):682–689
29. Lin DF, Yan SM, Zhao Y, Zhang W, Li MT, Zeng XF, Zhang FC, Dong Y (2010) Clinical and prognostic characteristics of
30. Ogbemudia AE, Yee SY, MacPherson GJ, Manson LM, Breusch SJ (2013) Preoperative predictors for allogenic blood transfusion in hip and knee arthroplasty for rheumatoid arthritis. Arch Orthop Trauma Surg 133(9):1315–1320

31. Malladi AS, Sack KE, Shiboski SC, Shiboski CH, Baer AN, Banushree R, Dong Y, Helin P, Kirkham BW, Li M, Sugai S, Umehara H, Vivino FB, Vollenweider CF, Zhang W, Zhao Y, Greenspan JS, Daniels TE, Criswell LA (2012) Primary Sjogren’s syndrome as a systemic disease: a study of participants enrolled in an international Sjogren’s syndrome registry. Arthritis Care Res (Hoboken) 64(6):911–8

32. Baimpa E, Dahabreh IJ, Voulgarelis M, Moutsopoulos HM (2009) Hematologic manifestations and predictors of lymphoma development in primary Sjogren syndrome: clinical and pathophysiologic aspects. Medicine (Baltimore) 88(5):284–293

33. IV (2001) NKF-K/DOQI clinical practice guidelines for anemia of chronic kidney disease: update 2000. Am J Kidney Dis 37(1 Suppl 1): S182–238

34. Wilson A, Yu HT, Goodnough LT, Nissenson AR (2004) Prevalence and outcomes of anemia in rheumatoid arthritis: a systematic review of the literature. Am J Med 116(Suppl 7A):50S-57S

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