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Day-case surgery for total hip and knee replacement: How safe and effective is it?

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- Multimodal protocols for pain control, blood loss management and thromboprophylaxis have been shown to benefit patients by being more effective and as safe (fewer iatrogenic complications) as conventional protocols.
- Proper patient selection and education, multimodal protocols and a well-defined clinical pathway are all key for successful day-case arthroplasty.
- By potentially being more effective, cheaper than and as safe as inpatient arthroplasty, day-case arthroplasty might be beneficial for patients and healthcare systems.

Keywords: day case surgery; hip arthroplasty; knee arthroplasty

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Introduction

The demand for total hip arthroplasty (THA) and total knee arthroplasty (TKA) is predicted to increase as a consequence of the increased prevalence of osteoarthritis, mainly resulting from longer life expectancy, the epidemic of obesity and changes in lifestyle.[1] It has been shown that higher morbidity and mortality is associated with prolonged hospital stay after total joint arthroplasty (TJA).[2] This current situation generates multiple issues for healthcare systems, principally an unsustainable high cost.[3]

In order to reduce the cost for society and improve the safety of TJA, there have been many efforts over the last decade to reduce the length of stay (LOS) after surgery. Therefore, protocols named either 'fast-track' or 'enhanced recovery' were introduced and found to be successful[4] compared with conventional pathways. While this led to a reduction in the LOS to around one to three days,[4] day-case or outpatient arthroplasty, defined as patient discharge on the same day after surgery,[5] is still relatively uncommon worldwide.

Day-case TJA may be worth considering, provided that it is shown to be beneficial for patients and healthcare systems as a safe, effective and cost-effective technique. This instructional review aims at answering this questioning by defining the safety and effectiveness of day-case arthroplasty.

Evidence supporting day-case arthroplasty

Both patients and healthcare systems appear to benefit from day-case joint replacement as it is substantially less expensive (around 30%) for healthcare systems[3] and with similar, if not better, safety (complications rate) and effectiveness (patient satisfaction and functionality) compared with conventional pathways for TKA,[6-16] unicompartmental knee arthroplasty (UKA)[12,14,17-20] or THA.[3,10,12,13,15,21-26] Table 1 summarizes the published readmission and complication rates associated with day-case arthroplasty. The literature at present (Table 1) reflects a Grade B practice recommendation[27] for day-case arthroplasty; based on the limited best available evidence, therefore, there is still a need for further high-quality randomized controlled trials.

Patient eligibility

A number of comorbidities such as diabetes, malnutrition, coagulopathy, high blood pressure, cardiovascular and pulmonary disease, and corticosteroid usage may make patients ineligible as there may be an increased risk of post-operative complications and consequently longer LOS.[19,28-30] A scoring system to identify patients suitable for day-case arthroplasty has recently been published.[28]

Table 1. Summary of published day-case arthroplasty readmission and complication rates

Authors	Study design	Type	Total follow-up (days)	Day-case readmissions (%)	Inpatient readmissions (%)	Day-case complications (%)	Inpatient complications (%)	Most common complication (day-case)	Most common complication (inpatient)
Courtney et al[10]	Retrospective comparison	TJA	30	0.33	0.54	9.59	17.83	Transfusion	Transfusion
Springer et al[11]	Retrospective comparison	TJA	30	8.76	5.66	4.38	1.89	Wound (not specified)	Wound (not specified)
Lovecchio[15]	Retrospective comparison	TJA	30	2.4	2.00	10.16	7.11	Transfusion	Transfusion
Goyal et al[22]	Prospective comparison	THA	42	0.89	0.93	0.89	3.70	Infection	Infection
Larsen et al[24]	Prospective observation	THA	42	0	–	0	–		
Hartog et al[21]	Prospective observation	THA	91	4.17	–	4.17	–	Seroma	
Dorr et al[25]	Prospective observation	THA	182	1.88	–	1.88	–	Intra-operative fracture	
Berger et al[26]	Prospective observation	THA	91	0.67	–	2	–	Transfusion	
Otero et al[12]	Retrospective comparison	THA	30	2.02	13.38	5.62	17.25	Transfusion	Transfusion
Nelson et al[23]	Retrospective comparison	THA	30	1.43	2.97	7.86	13.43	Transfusion	Transfusion
Aynardi et al[3]	Retrospective comparison	THA	90	0	0	1.68	0	Intra-operative calcar cracks	
Berger et al[16]	Prospective observation	TKA	91	4.16	–	4.16	–	Wound (delayed healing)	
Lovald et al[6]	Retrospective comparison	TKA	730	1.6	6.6	29.7	39.67	Knee stiffness	Deep vein thrombosis
Bovonratwet[9]	Retrospective comparison	TKA	30	2.65	3.01	6.56	16.06	Transfusion	Transfusion
Otero et al[12]	Retrospective comparison	TKA	30	1.93	12.75	5.54	20.18	Transfusion	Transfusion
Berger et al[26]	Retrospective comparison	TKA	91	10	–	10	–	Transfusion	
Kort et al[14]	Prospective comparison	UKA	91	5	0	5	0	Knee stiffness	
Hoorntje et al[17]	Prospective comparison	UKA	91	5.5	0	5.5	0	Wound (ooze)	
Gondusky et al[18]	Prospective observation	UKA	60	0.63	–	2.5	–	Revision (displacement of mobile bearing and progression of arthritis)	
Otero et al[12]	Retrospective comparison	UKA	30	3.64	5.18	4.48	19.90	Wound (not specified)	Transfusion
Berger et al[26]	Retrospective observation	UKA	91	0	–	0	–		
Cross and Berger[20]	Retrospective observation	UKA	91	0.95	–	0.95	–	Revision (infection and exchange of liner)	

The proportion of eligible patients scheduled for TJA who undergo day-case surgery seems to vary substantially between private and public hospitals (90% *vs* 24% of patients, respectively).[19,20,31]

Patient education

Before surgery, it is important to ensure patients have adequate support in place at home and that someone is available to help them after surgery.[32] Patient education before surgery has been shown to decrease LOS in TKA[33] and is especially important in certain groups, for example, patients with anxiety.[34]

Anaesthesia

The choice between general anaesthesia (GA) or regional anaesthesia (RA) for day-case arthroplasty is controversial[35] and both may be acceptable. While an apparent shorter LOS and lower morbidity and mortality were initially shown with the use of GA compared with RA,[36] more recent research suggested the opposite.[37] Regarding oral intake, it is recommended that patients do not have clear liquids at least 2 hours before surgery and avoid solid food for 6 hours before surgery.[38] Therefore, post-operatively, early oral nutrition and hydration should be provided.

Analgesia

One pre-requisite to promote day-case surgery is to achieve pain control with few side-effects. This has been shown to be best achieved with a multimodal pain control protocol.[39] The administration of medication is usually started before surgery[39] with drugs such as paracetamol, cyclooxygenase-2 inhibitors[40] and gabapentinoids,[41] followed during surgery with local infiltration analgesia (LIA) containing a long-acting local anaesthetic and post-operatively with a combination of oral medication. Compared with RA, LIA has fewer potential complications such as nerve damage, autonomic blockade, spinal haematoma formation and infection and also preserves motor function for early mobilization,[42] but it may have more of a role to play in day-case TKA than THA.[43] The effectiveness of post-operative wound catheters is unclear but there may be an increased risk of infection with their use.[44] Corticosteroids can also be used anytime pre-, intra- and post-operatively as an analgesic and anti-emetic and have proven effectiveness and safety with no increased risk of surgical site infection.[45]

Venous thromboembolism (VTE) prophylaxis

Preventing post-operative VTE without significantly increasing the risk of bleeding is best accomplished with a multimodal patient-specific approach using non-pharmacological (hydration, early mobilization, calf compression with stockings or an intermittent pneumatic compression device (IPCD)) and pharmacological means of prophylaxis (such as aspirin or anticoagulant drug).[46,47] The choice of which combination to use is based on VTE and bleeding risks, aiming to limit the use of anticoagulants (low molecular weight heparin (LMWH) or warfarin). In low-risk patients that have no previous history of VTE, the use of pharmacological or mechanical thromboprophylaxis with an IPCD appears to be acceptable.[46] There is still no consensus on the optimum drug for thromboprophylaxis and both the American Academy of Orthopaedic Surgeons[47] and the American College of Chest Physicians[46] support the use of either aspirin or LMWH or warfarin (with an international normalized ratio (INR) of < 2.0) for low-risk patients. However, a recent large multicentre study concluded that there was no difference in VTE occurance using aspirin or LWMH in TKA and THA.[48] Novel oral anticoagulants such as rivaroxaban appear to be superior to aspirin and LMWH in preventing VTE, but are associated with an increased risk of wound complications and major bleeding.[49] In high-risk patients, such as those who have had VTE in the past, the combination of chemical and mechanical prophylaxis is recommended.[46,47]

Blood loss management

Post-operative anaemia is a common complication in day-case and inpatient TJA (Table 1) and also requires a multimodal approach for effective management. There is no evidence to suggest the optimal timing of haemoglobin (Hb) checks after day-case arthroplasty or whether it is necessary at all. In non-day-case arthroplasty, it appears that the maximum Hb decrease is seen after 4 days.[50] Pre-operatively, blood loss with day-case TJA can be minimized with patient selection (e.g. patients with a Hb > 13 g/dL[51]) or patient optimization by, for example, giving erythropoietin to anaemic patients pre-operatively.[52] Intra-operatively, tranexamic acid has proven to be effective and safe for haemostasis in TJA and is now considered as a game-changer for blood loss management.[53] The effects of tourniquet use are unclear at present, with earlier systematic reviews and meta-analyses suggesting no reduction in total blood loss,[54] while a more recent systematic review and meta-analysis suggested the opposite.[55] Suction drainage does not appear to offer any benefits in TKA or THA and actually appears to increase the need for transfusion post-operatively.[56] Controlled hypotension may be another way to achieve haemostasis during surgery.[57]

Surgical technique

While most day-case TJA publications used minimally invasive muscle-sparing approaches,[3,16,18,20,22,25,26] successful day-case TJA may also be achieveable with conventional approaches.[9-11] Alternative minimally invasive muscle-sparing approaches for TKA and THA have been shown to speed up recovery time and would probably help with successful day-case TJA.[3,16,25,26]

Similarly, kinematic alignment of knee implants may have more of a role to play in day-case arthroplasty as it appears to lead to faster recovery.[58] However, long-term outcomes need to be studied before mainstream use of the kinematic alignment technique.

Preventing wound ooze is important when sending patients home on the day of surgery, and although very little definitive evidence exists regarding different methods of closure and their effects on LOS and ooze, it would seem that the combined use of subcuticular sutures[59] with tissue adhesives[60] is a good way to help prevent wound ooze and reduce LOS.[61]

Rehabilitation

Early post-operative patient nutrition and mobilization are key for effective rehabilitation and in facilitating discharge. Physiotherapy appears to be more important for TKA than THA[62] and can be achieved with equal effectiveness by patients in their own home with telephone follow-up instead of on the ward.[63] Other key factors in early mobilization are good pain control,[39] avoiding the use of surgical drains[56] and preventing postural hypotension after surgery with crystalloid volume expansion.

Table 2. Example clinical pathway and criteria to select patients suitable for day-case arthroplasty

Patient suitability criteria	Pre-operatively	Intra-operatively	Post-operatively
• American Society of Anaesthesiologists class 2 or below • No mobility aids • Good social support • Haemoglobin of >13 g/dL • No previous VTE • No cardiopulmonary disease or diabetes • No long-term steroid usage • BMI < 40 • No cognitive impairment	• Patient education • Pre-medication with paracetamol, a gabapentinoid, a cyclooxygenase-2 inhibitor, a corticosteroid, an anti-emetic and opioid	• Regional or general anaesthesia • Minimally invasive approach • Tranexamic acid • Local infiltration analgesia • Controlled hypotension	• Immediate mobilization, nutrition and hydration • Self-directed physiotherapy at home for total knee replacement (if suitable) • Crystalloid rehydration if volume depletion • Aspirin for low-risk, novel oral anticoagulant + mechanical thromboprophylaxis for high-risk patients • Discharge home if < 500 mL blood loss • Haemoglobin check 0-4 days post-operatively

Patient discharge criteria

There does not appear to be widespread agreement in the literature on day-case arthroplasty as to which criteria have to be fulfilled before a patient can be safely discharged. Some authors discharge patients as long as they have normal vital signs, adequate pain control and safe mobilization.[19,20] However, others also take into account blood loss and only discharge patients with < 500 mL intra-operative blood loss[31] or with a Hb of > 9.7g/dL.[21] Further work is needed on developing and establishing the most reliable criteria for safe discharge after day-case TJA.

Day-case arthroplasty protocols

Proper patient selection, education and a well-defined clinical pathway are keys for successful day-case TJA. The majority of publications on successful day-case TJA selected patients aged no older than 65 to 80 years,[11,16,17,22,26] with a maximum body mass index (BMI) of 35 to 40 kg/m^2,[11,16,22,24,25] and no significant comorbidities such as diabetes,[21] cardiopulmonary disease[14,17,22] or previous VTE.[11,16,26] Most authors reported using a minimally invasive approach,[3,16,18,20,22,25,26] tranexamic acid,[14,17] RA or GA,[14,17,25] multimodal opioid-sparing analgesia[14,17,21,22] and aspirin for VTE prophylaxis.[3,16,18,19,25,26] There appears to be widespread variation in the literature on the choice of closure materials,[18,21] the use of suction drains and urinary catheters.[14,16,17,19,20,26] Based on the available literature, some of the possible key features of safe and effective day-case arthroplasty are summarized in Table 2.

Conclusion

By potentially being more effective, cheaper than and as safe as inpatient arthroplasty, day-case arthroplasty may be beneficial for some patients and healthcare systems. Proper patient selection and education, multimodal-based protocols and a well-defined clinical pathway are key to successful day-case TJA. Multimodal-based protocols for pain control, blood loss management and thromboprophylaxis have been shown to benefit patients by being as effective as but safer than conventional protocols. In order to guarantee its safety and effectiveness, there is still a need for further prospective studies on the long-term outcomes after day-case arthroplasty as well as clinical trials to demonstrate the clinical relevance compared with current standards.

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REFERENCES

1. **Kurtz S, Ong K, Lau E, Mowat F, Halpern M.** Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg [Am]* 2007;89-A:780-785.

2. Maempel JF, Clement ND, Ballantyne JA, Dunstan E. Enhanced recovery programmes after total hip arthroplasty can result in reduced length of hospital stay without compromising functional outcome. *Bone Joint J* 2016;98:475-482.

3. Aynardi M, Post Z, Ong A, Orozco F, Sukin DC. Outpatient surgery as a means of cost reduction in total hip arthroplasty: a case-control study. *HSS J* 2014;10:252.

4. Sutton JC III, Antoniou J, Epure LM, et al. Hospital discharge within 2 days following total hip or knee arthroplasty does not increase major-complication and readmission rates. *J Bone Joint Surg [Am]* 2016;98:1419-1428.

5. Castoro C, Bertinato L, Baccaglini U, Drace CA, McKee M. *Policy brief – day surgery: making it happen*. Geneva: World Health Organization, 2007. http://www.euro.who.int/__data/assets/pdf_file/0011/108965/E90295.pdf (date last accessed 10 July 2017)

6. Lovald ST, Ong KL, Malkani AL, et al. Complications, mortality, and costs for outpatient and short-stay total knee arthroplasty patients in comparison to standard-stay patients. *J Arthroplasty* 2014;29:510-515.

7. Kolisek FR, McGrath MS, Jessup NM, Monesmith EA, Mont MA. Comparison of outpatient versus inpatient total knee arthroplasty. *Clin Orthop Relat Res* 2009;467:1438–1442.

8. Schotanus MG, Bemelmans YF, Grimm B, Heyligers IC, Kort NP. Physical activity after outpatient surgery and enhanced recovery for total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2017;25:3366-3371.

9. Bovonratwet P, Ondeck NT, Nelson SJ, et al. Comparison of outpatient vs inpatient total knee arthroplasty: an ACS-NSQIP analysis. *J Arthroplasty* 2017;32:1773-1778.

10. Courtney PM, Boniello AJ, Berger RA. Complications following outpatient total joint arthroplasty: An analysis of a national database. *J Arthroplasty* 2017;32:1426-1430.

11. Springer BD, Odum SM, Vegari DN, Mokris JG, Beaver WB. Impact of inpatient versus outpatient total joint arthroplasty on 30-day hospital readmission rates and unplanned episodes of care. *Orthop Clin North Am* 2017;48:15-23.

12. Otero JE, Gholson JJ, Pugely AJ, et al. Length of hospitalization after joint arthroplasty: does early discharge affect complications and readmission rates? *J Arthroplasty* 2016;31:2714-2725.

13. Bovonratwet P, Webb ML, Ondeck NT, et al. Definitional differences of 'outpatient' versus 'inpatient' THA and TKA can affect study outcomes. *Clin Orthop Relat Res* 2017;475:2917-2925.

14. Kort NP, Bemelmans YF, Schotanus MG. Outpatient surgery for unicompartmental knee arthroplasty is effective and safe. *Knee Surg Sports Traumatol Arthrosc* 2017;25:2659-2669.

15. Lovecchio F, Alvi H, Sahota S, Beal M, Manning D. Is outpatient arthroplasty as safe as fast-track inpatient arthroplasty? A propensity score matched analysis. *J Arthroplasty* 2016;31:197-201.

16. Berger RA, Sanders S, Gerlinger T, et al. Outpatient total knee arthroplasty with a minimally invasive technique. *J Arthroplasty* 2005;20:33-38.

17. Hoorntje A, Koenraadt KL, Boevé MG, van Geenen RC. Outpatient unicompartmental knee arthroplasty: who is afraid of outpatient surgery? *Knee Surg Sports Traumatol Arthrosc* 2017;25:759-766.

18. Gondusky JS, Choi L, Khalaf N, et al. Day of surgery discharge after unicompartmental knee arthroplasty: an effective perioperative pathway. *J Arthroplasty* 2014;29:516-519.

19. Sher A, Keswani A, Yao DH, et al. Predictors of same-day discharge in primary total joint arthroplasty patients and risk factors for post-discharge complications. *J Arthroplasty* 2017;32:S150-156.

20. Cross MB, Berger R. Feasibility and safety of performing outpatient unicompartmental knee arthroplasty. *Int Orthop* 2014;38:443-447.

21. Hartog YM, Mathijssen NM, Vehmeijer SB. Total hip arthroplasty in an outpatient setting in 27 selected patients. *Acta Orthop* 2015;86:667-670.

22. Goyal N, Chen AF, Padgett SE, et al. Otto Aufranc Award: A multicenter, randomized study of outpatient versus inpatient total hip arthroplasty. *Clin Orthop Relat Res* 2017;475:364-372.

23. Nelson SJ, Webb ML, Lukasiewicz AM, et al. Is outpatient total hip arthroplasty safe? *J Arthroplasty* 2017;32:1439-1442.

24. Larsen JR, Skovgaard B, Prynø T, et al. Feasibility of day-case total hip arthroplasty: a single-centre observational study. *Hip Int* 2017;27:60-65.

25. Dorr LD, Thomas DJ, Zhu J, et al. Outpatient total hip arthroplasty. *J Arthroplasty* 2010;25:501-506.

26. Berger RA, Sanders SA, Thill ES, Sporer SM, Della Valle C. Newer anesthesia and rehabilitation protocols enable outpatient hip replacement in selected patients. *Clin Orthop Relat Res* 2009;467:1424-1430.

27. ASPS Scale for Grading Recommendations. American Society of Plastic Surgeons. https://www.plasticsurgery.org/documents/medical-professionals/health-policy/evidence-practice/ASPS-Scale-for-Grading-Recommendations.pdf (date last accessed 14 September 2017).

28. Meneghini RM, Ziemba-Davis M, Ishmael MK, Kuzma AL, Caccavallo P. Safe selection of outpatient joint arthroplasty patients with medical risk stratification: the "Outpatient Arthroplasty Risk Assessment Score". *J Arthroplasty* 2017;32:2325-2331.

29. Lovald S, Ong K, Lau E, et al. Patient selection in outpatient and short-stay total knee arthroplasty. *J Surg Orthop Adv* 2014;23:2-8.

30. Berger RA, Kusuma SK, Sanders SA, Thill ES, Sporer SM. The feasibility and perioperative complications of outpatient knee arthroplasty. *Clin Orthop Relat Res* 2009;467:1443-1449.

31. Gromov K, Kjærsgaard-Andersen P, Revald P, Kehlet H, Husted H. Feasibility of outpatient total hip and knee arthroplasty in unselected patients. *Acta Orthop* 2017;88:516-521.

32. Theiss MM, Ellison MW, Tea CG, et al. The connection between strong social support and joint replacement outcomes. *Orthopedics* 2011;34:357.

33. Jones S, Alnaib M, Kokkinakis M, et al. Pre-operative patient education reduces length of stay after knee joint arthroplasty. *Ann R Coll Surg Engl* 2011;93:71-75.

34. McDonald S, Page MJ, Beringer K, Wasiak J, Sprowson A. Preoperative education for hip or knee replacement. *Cochrane Database Syst Rev* 2014;5:CD003526.

35. Johnson RL, Kopp SL, Burkle CM, et al. Neuraxial vs general anaesthesia for total hip and total knee arthroplasty: a systematic review of comparative-effectiveness research. *Br J Anaesth* 2016;116:163-176.

36. Macfarlane AJ, Arun Prasad G, Chan VW, Brull R. Does regional anesthesia improve outcome after total knee arthroplasty? *Clin Orthop Relat Res* 2009;467:2379-2402.

37. Harsten A, Kehlet H, Ljung P, Toksvig-Larsen S. Total intravenous general anaesthesia vs. spinal anaesthesia for total hip arthroplasty: a randomised, controlled trial. *Acta Anaesthesiol Scand* 2015;59:298-309.

38. American Society of Anesthesiologists Committee. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report by the American Society of Anesthesiologists Committee on Standards and Practice Parameters. *Anesthesiology* 2011;114:495-511.

39. Halawi MJ, Grant SA, Bolognesi MP. Multimodal analgesia for total joint arthroplasty. *Orthopedics* 2015;38:e616-625.

40. Munteanu AM, Florescu SC, Anastase DM, Stoica CI. Is there any analgesic benefit from preoperative vs. postoperative administration of etoricoxib in total knee arthroplasty under spinal anaesthesia? A randomised double-blind placebo-controlled trial. *Eur J Anaesthesiol* 2016;33:840-845.

41. Han C, Li XD, Jiang HQ, Ma JX, Ma XL. The use of gabapentin in the management of postoperative pain after total knee arthroplasty: A PRISMA-compliant meta-analysis of randomized controlled trials. *Medicine* 2016;95:e3883.

42. Marques EM, Jones HE, Elvers KT, et al. Local anaesthetic infiltration for peri-operative pain control in total hip and knee replacement: systematic review and meta-analyses of short-and long-term effectiveness. *BMC Musculoskelet Disord* 2014;15:220.

43. Andersen LØ, Kehlet H. Analgesic efficacy of local infiltration analgesia in hip and knee arthroplasty: a systematic review. *Br J Anaesth* 2014;113:360-374.

44. Sun XL, Zhao ZH, Ma JX, et al. Continuous local infiltration analgesia for pain control after total knee arthroplasty: a meta-analysis of randomized controlled trials. *Medicine (Baltimore)* 2015;94:e2005.

45. Hartman J, Khanna V, Habib A, et al. Perioperative systemic glucocorticoids in total hip and knee arthroplasty: A systematic review of outcomes. *J Orthop* 2017;14: 294-301.

46. Falck-Ytter Y, Francis CW, Johanson NA, et al. Prevention of VTE in orthopedic surgery patients: antithrombotic therapy and prevention of thrombosis: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest* 2012;141(2 Suppl): e278S-e325S.

47. Jacobs JJ, Mont MA, Bozic KJ, et al. American Academy of Orthopaedic Surgeons clinical practice guideline on: preventing venous thromboembolic disease in patients undergoing elective hip and knee arthroplasty. *J Bone Joint Surg [Am]* 2012;94:746-747.

48. Anderson DR, Dunbar MJ, Bohm ER, et al. Aspirin versus low-molecular-weight heparin for extended venous thromboembolism prophylaxis after total hip arthroplasty a randomized trial. *Ann Intern Med* 2013;158:800-806.

49. Ning GZ, Kan SL, Chen LX, et al. Rivaroxaban for thromboprophylaxis after total hip or knee arthroplasty: a meta-analysis with trial sequential analysis of randomized controlled trials. *Sci Rep* 2016;6:23726.

50. Chen ZY, Wu HZ, Zhu P, Feng XB. Postoperative changes in hemoglobin and hematocrit in patients undergoing primary total hip and knee arthroplasty. *Chin Med J (Engl)* 2015;128:1977-1979.

51. Moráis S, Ortega-Andreu M, Rodríguez-Merchán EC, et al. Blood transfusion after primary total knee arthroplasty can be significantly minimised through a multimodal blood-loss prevention approach. *Int Orthop* 2014;38:347-354.

52. Zhao Y, Jiang C, Peng H, et al. The effectiveness and safety of preoperative use of erythropoietin in patients scheduled for total hip or knee arthroplasty: A systematic review and meta-analysis of randomized controlled trials. *Medicine (Baltimore)* 2016;95:e4122.

53. Shang J, Wang H, Zheng B, Rui M, Wang Y. Combined intravenous and topical tranexamic acid versus intravenous use alone in primary total knee and hip arthroplasty: A meta-analysis of randomized controlled trials. *Int J Surg* 2016;36:324-329.

54. Smith TO, Hing CB. Is a tourniquet beneficial in total knee replacement surgery? A meta-analysis and systematic review. *Knee* 2010;17:141-147.

55. Alcelik I, Pollock RD, Sukeik M, et al. A comparison of outcomes with and without a tourniquet in total knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials. *J Arthroplasty* 2012;27:331-340.

56. Sharma GM, Palekar G, Tanna DD. Use of closed suction drain after primary total knee arthroplasty—an overrated practice. *SICOT J* 2016;2:39.

57. Paul JE, Ling E, Lalonde C, Thabane L. Deliberate hypotension in orthopedic surgery reduces blood loss and transfusion requirements: a meta-analysis of randomized controlled trials. *Can J Anaesth* 2007;54:799-810.

58. Dossett HG, Estrada NA, Swartz GJ, LeFevre GW, Kwasman BG. A randomised controlled trial of kinematically and mechanically aligned total knee replacements. *Bone Joint J* 2014;96:907-913.

59. Krishnan R, MacNeil SD, Malvankar-Mehta MS. Comparing sutures versus staples for skin closure after orthopaedic surgery: systematic review and meta-analysis. *BMJ Open* 2016;6:e009257.

60. Coulthard P, Esposito M, Worthington HV, et al. Tissue adhesives for closure of surgical incisions. *Cochrane Database Syst Rev* 2010;5:CD004287.

61. Eggers MD, Fang L, Lionberger DR. A comparison of wound closure techniques for total knee arthroplasty. *J Arthroplasty* 2011;26:1251-1258.

62. Artz N, Elvers KT, Lowe CM, et al. Effectiveness of physiotherapy exercise following total knee replacement: systematic review and meta-analysis. *BMC Musculoskelet Disord* 2015;16:15.

63. Florez-García M, García-Pérez F, Curbelo R, et al. Efficacy and safety of home-based exercises versus individualized supervised outpatient physical therapy programs after total knee arthroplasty: a systematic review and meta-analysis. *Knee Surg Sports Traumatol Arthrosc* 2017;25:3340-3353.