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Rapid recovery protocol after Total Hip and Knee Arthroplasty that is safe and effective in most clinical environments

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ABSTRACT

Background: Rapid recovery protocols, as well as minimally invasive techniques, are used in daily practice in almost all surgical specialties. Rapid Rehabilitation Protocols are the most modern multifactorial approach for patients with hip, knee or spine surgery. Fast track protocols consist of a combination of minimally invasive surgical techniques, modified anesthesia, staged and personalized analgesia. These protocols have a steep learning curve and require the cooperation of all involved specialties (Orthopaedic surgeon, anesthesiologist, physiotherapist, nursing staff).

Material and Methods: The study was conducted simultaneously at the 2nd Orthopaedic Department of the National & Kapodistrian University of Athens, and other private hospitals for a period of 7 years (2013-2020). In total, 826 arthroplasties were performed by the senior author (GCB), of which 515 were total hip arthroplasties (THA) and 311 total knee arthroplasties (TKA). The patients underwent combined spinal, epidural and intravenous general anesthesia with preservation of automatic breathing as it is considered to contribute to decreased length of stay (LOS), short-term complications, and transfusions. The rapid recovery protocol includes minimal invasive techniques, use of local infiltration anesthesia (LIA), use of tranexamic acid, low transfusion threshold, early mobilization, and immediate initiation of oral nutrition as well as complete abstinence from intravenous or intramuscular opioids that may cause nausea and vomiting.

Results: LOS range was 0-2 days for THAs with mean value: 1.33, and 1-2 days for TKAs with mean value: 1.54. Transfusion with 1 unit of packed Red Blood Cells (PRBCs) was carried out for 14 patients undergoing THA (2.7%), and 4 patients undergoing TKA (1.3%). The difference in hemoglobin values preoperative and postoperative was -2.47 g/dL for THAs and -1.83 g/dL for TKAs. Two THA patients (0.3%) were re-admit-

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ted on day 17 with acute infection and were treated with DAIR and exchange of the modular parts of the arthroplasty. One patient (0.2%) was re-admitted on day 25 due to anterior dislocation and 2 more patients had posterior dislocations. All cases were treated with closed reduction and were discharged at home on the same or next day. Another patient had recurrent dislocations and is scheduled for revision. Two TKA patients (0.6%) were re-admitted on day 15 and 18 with acute PJI and were treated successfully with DAIR. One patient (0.4%) was admitted on day 21 with periprosthetic fracture of the femur, related to a fall, treated with ORIF. One patient (0.4%) was admitted 2 months post-op with periprosthetic joint infection, treated with 2-stage revision (using a spacer). One elderly patient died at home on the 3rd postop day due to MI.
Conclusions: Rapid recovery protocols are feasible and can be applied both at academic departments within NHS as well as private clinics. "Ownership" of these protocols by a small team of surgeons, anesthetists, physiotherapists and nursing staff is the most important requirement for success.

KEYWORDS: Total Hip Arthroplasty; Total Knee Arthroplasty; rapid recovery; rapid rehabilitation

Background

Rapid recovery protocols as well as minimally invasive techniques are now used in all surgical specialties. The first official report was made by the Danish surgeon Henrik Kehlet in 1997 [1]. ERAS protocols in the beginning were used in patients who underwent abdominal and rectal surgery. Bardram studied nine cases of patients receiving epidural anesthesia, early mobilization, and immediate initiation of oral nutrition in the context of a rapid recovery protocol [2]. The reduction of the postoperative pain contributes to the patients' better rehabilitation. The number of the postoperative complications decreases and as a result the hospital stay.

Rapid Rehabilitation Protocols are the most modern multifactorial approach for patients with hip, knee, or spine surgery. Fast track protocols are a combination of minimally invasive surgical techniques, modified anesthesia, staged analgesia, and personalized nutrition. These protocols have a large learning curve and require the cooperation of many different specialties (orthopedic surgeon, anesthesiologist, physiotherapist, nursing staff). The number of patients undergoing primary total hip or knee arthroplasty continues to increase with costs remaining high for the public health system [3]. Not only is cost reduction necessary but also newer practices require shorter length of stay. The reduction of postoperative complications, readmission rate, and improved functional recovery are the goals of the fast-track protocols [3,4]. ERAS protocols include preoperative, intraoperative and postoperative interventions [5].

Current rapid recovery protocols are difficult because they involve many processes that are complicated, costly and time consuming. In the present study we present a simplified protocol with no inclusion criteria that is feasible for many, if all, clinical environments.

Materials and Methods

Between 2013-2020, we retrospectively collected data of unilateral total hip (THA) and knee arthroplasties (TKA) conducted at a university and a private clinic. There were no inclusion criteria; all patients that had no contra-indication to undergo THA or TKA were included in the study.

A total of 470 patients (155 men, 315 women) 27-94 years old (mean: 68.4) underwent 515 THAs and 287 patients (49 men, 238 women) 27-94 years old (mean: 74.7) underwent 311 TKAs. The surgeon conducted preoperatively proper education of the procedures following surgery, the rapid recovery protocol, management of the expectations of the patient and discharge planning [6, 7, 8, 9, 10, 11, 12, 13, 14, 15]. Pre-operative evaluation was arranged about 7-10 days before surgery at the university clinic and

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1-2 days before surgery at the private clinics.

All patients signed an informed consent. Pre-operative evaluation included a thorough interview with the patient about their history, blood tests, 12 lead ECG and chest, lumbar spine, pelvis/knee x-rays using a magnification ball, and if necessary, a full leg x-ray to check leg length discrepancy. At all instances the patient was informed about the rapid recovery protocol and that he/she will walk after surgery and leave hospital next day.

Preoperative planning was performed in all 100% of the cases to ensure the correct choice of the size and type of prostheses, their proper placement within a short OR time.

Patients were advised to bathe with povidone-iodine the night before surgery, to reduce the population of skin microorganisms. Pre-surgery fasting of about 6-8 hours before surgery was advised [16]. The patients were admitted on surgery day.

Two hours prior to incision, chemoprophylaxis with Vancomycin 15 mg/Kg is administered intravenously, due to the extended infusion time [17, 18].

The patient underwent combined spinal, epidural and intravenous general anesthesia with preservation of automatic breathing [19], although modern general anesthesia techniques with limitation of narcotics and certain inhalants can be also used [20]. In THAs the spinal anesthesia was performed at L2-L3 or L3-L4 spaces with administration of 15 μg of fentanyl and 13 mg Ropivacaine 0.75%. In TKAs, spinal anesthesia was performed at T12-L1 or L1-L2 spaces. In THAs the epidural catheter was removed immediately after surgery. In TKAs, the epidural catheter remained for analgesia with administration of fentanyl 3 μg/mL and ropivacaine 0.2% 2 mg/mL with flow 2-3 mL/hour.

Fifteen minutes before surgery, dexamethasone 8 mg is administered intravenously, to reduce postoperative nausea, vomiting and acute pain [21], Cefuroxime axetil 1.5 g IV as chemoprophylaxis and IV Tranexamic acid (TXA) 15 mg/Kg for blood loss control [22]. IV administration of TXA was repeated 3 hours later. TXA was also administered intra-articularly (3g, after closure of the fascia, with closed drainage), to reduce hemorrhage and the need for transfusion with blood [23].

Hypotensive anesthesia further contributes to blood loss control [22]. A tourniquet was used in TKAs, although there are clinical trials suggesting that tourniquet does not reduce the total blood loss from surgery, while having a negative impact on early recovery of muscle strength and lower extremity function [24].

No urethral catheter was used, although it seems that this practice slightly increases the incidence of Postoperative Urinary Retention [25].

Mini posterolateral approach with repair of hip adductors [26] was utilized in THAs using a cementless technique with porous coated acetabular prosthesis and porous coated 3D tapered or (HA) fully coated stem. Maximum effort was taken to avoid length discrepancies [27].

A medial parapatellar approach was used in TKAs. The implant utilized in TKAs was always cemented posterior stabilized femoral component and rotating platform tibial component. Tibial stemed implant was used in obese patients (BMI>35) [28]. However, the ERAS Society makes no recommendations for surgical technique [29].

Local Infiltration Analgesia was utilized in all cases with a cocktail of Bupivacaine 0.5% (24 mL), Morphine sulphate 8 mg (0.8 mL), Epinephrine (1:1000) 300 μg (0.3 mL), Methylprednisolone acetate 40 mg (1 mL), Clonidine 1 μg/Kg, Cefuroxime axetil 750 mg (10 mL) and Sodium chloride 0.9% (to reach volume 60 mL of total solution) [30]. Effectiveness of LIA in reduction of postoperative pain at THAs is ambiguous [31, 32, 33].

Proper hemostasis after tourniquet release and a drainage is also used in TKAs. However, some studies show that not only does it not help prevent hematomas, but it also increases the risk of blood loss because it eliminates the tamponade effect [34, 35]. The drainage remained closed for 2 hours and opened every 2 hours for about 5 minutes.

Warming blankets were used to prevent heat loss, as it is shown that normothermia reduces intraoperative bleeding, cardiovascular complications, and postoperative wound infection [36, 37].

Mobilization begins 1 to 3 hours after surgery: The patient was always motivated by the surgeon to stand up and walk using a walker or crutches.

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The patient is also taught how to turn to the side, get out of bed, sit, and walk up and down the stairs. Physical therapy exercises are also shown on day 0 [38].

Tramadol caps 50 mg 1 x 4, Celecoxib caps 200 mg 1 x 2, Acetaminophen 1000 mg IV 1 x 3 were administered on day 0 for the management of postoperative pain. There was a strict order for complete abstinence of intravenous or intramuscular opioids to prevent nausea and vomiting [20].

To reduce postoperative pain, swelling and blood loss, ice-therapy was used in TKAs for at least 20 min every 4 hours, not counting sleeping hours. [39]

Transfusion threshold for most patients was kept at 8 g/dL. Patients with postoperative HGB < 8 g/dL seem to have longer hospital stay and greater rates of readmissions [40]. Patients underwent according to protocol a blood check for HCT, HGB and PLT in the afternoon of day 0 and in the morning of day 1.

Anticoagulation medication started 6-10 hours after surgery with administration of Enoxaparin 4000 IU SC once, continued by Apixaban tab 2.5 mg twice daily from day 1 and for a total of 30 days.[41]

Patients were discharged home if proper pain management and mobilization was achieved. Discharge criteria for all patients were: the ability to ambulate 25 m at ground level, walk up and down the stairs, get out of bed to standing position, go to bathroom and use of the toilet independently, void independently, tolerate oral diet, maintain vital signs within normal limits without symptoms, satisfactory pain control, abstinence of nausea or vomiting, patient comfort with discharge and appropriate transportation and home assistance [42, 43].

Postoperative pain is managed at home with administration of Acetaminophen tab 1000 mg PRN (no more than 3g/day) for THAs and Acetaminophen tab 1000 mg 1 x 3, Etoricoxib 90 mg 1 x 1 (stop if SAP>160 mm Hg), Tramadol caps 50 mg 1 x 3 for TKAs.

Close communication with patients via telephone and email or viber ensured patients' safety and satisfaction [44].

Blood tests (HCT, HGB, PLT) were required on 5th post-op day, and, if necessary, on 10th post-op day, to monitor the trend of postoperative anemia. Removal of sutures (if applicable) was arranged on day 17. Clinical and radiological reassessment arranged at the 1st, 3rd and 12th postop months.

Results

The length of stay was 0-2 days for THAs with mean value of 1.33 days, and 1-2 days for TKAs with mean of 1.54 days. All patients were mobilized successfully on day 0, 1 to 3 hours after surgery. Postoperative Urinary Retention was noted in 10 cases necessitating catheter placement.

Transfusion with 1 RBC was carried out for 14 patients undergoing THA (2.7%), and in 4 patients undergoing TKA (1.3%). Due to early transfusion on day 0 or 1, no delay of discharge was noted.

Five TKA patients developed postoperative transient drop foot that occurred in the evening of day) and recovered next morning. These patients were discharged on day 2.

ΔHGB (difference of HGB at discharge from pre-surgery) for THAs was -2.47 g/dL and for TKAs -1.83 g/dL.

Two THA patients (0.3%) were re-admitted on day 17 with acute infection and were treated with DAIR and exchange of the modular parts of the arthroplasty. One patient (0.2%) was re-admitted on day 25 due to anterior dislocation and 2 more patients had posterior dislocations. All cases were treated with closed reduction and were discharged at home on the same or next day. Another patient had recurrent dislocations and is scheduled for revision.

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One elderly patient died at home on the 3rd postop day due to MI.

There were no patients lost at the follow-up.

Discussion

In our study all patients underwent combined anes-

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thesia (spinal, epidural and intravenous general anesthesia with preservation of automatic breathing). General anesthesia with use of fentanyl and propofol, succinylcholine or rocuronium only for intubation, and sevoflurane for maintenance of anesthesia, is also a comparable and acceptable method for rapid recovery protocols at least in THAs. In TKAs epidural anesthesia is a critical part of multimodal analgesic strategy [40].

The use of tourniquet in TKAs to avoid osseous bleeding is necessary during the application of cement to achieve optimum cement technique. Nevertheless, it is not necessary during the whole surgical procedure, if hypotensive epidural anesthesia, optionally augmented by IV epinephrine [45]) is accomplished, resulting in reduced blood loss and transfusion rates [46]. The intraoperative use of tourniquet is recognized as a cause of postoperative pain and reduction in strength of quadriceps for up to 3 months postoperatively [24]. However, Harsten et al showed that, in fast track TKA, not using tourniquet compared to using a tourniquet was not superior in preserving knee-extension strength at the 48-h primary endpoint [47].

Zhang Q et al showed no difference in range of motion, quadriceps strength, total (intraoperative and postoperative) blood loss, hemoglobin drop, superficial wound, or prosthetic joint infection, DVT and hospital stay, with or without the use of a drain [34]. In some cases (eg, atrial fibrillation), in which the patients are on double anticoagulation the use of drainage is strongly recommended to prevent postoperative hematomas. Aspirin as VTE prevention, may probably give surgeons more confidence not to use a drainage after TKA.

Local infiltration analgesia in THAs has been tested by many studies. There is little evidence to support LIA in THA, provided that multimodal oral non-opioid pain treatment is used [49, 50]. On the contrary in TKAs, most trials reported reduced pain and opioid requirements when LIA was utilized compared with a control group treated with placebo / no injection [51]. LIA may provide postoperative pain relief 6-12 hours after surgery [52].

Current clinical practice has shown that THA as an outpatient procedure is feasible and safe; patients have the surgery in the morning, and in the evening, they are discharged at home with instruction for close monitoring during the early postoperative period. Achieving the same result with TKAs, with satisfactory management of pain without epidural analgesia, since the catheter is removed after 8-12 hours, using only multimodal pain control, is still a true challenge.

Conclusion

Rapid recovery protocols are feasible and can be applied both at private clinics and in academic departments without complicated and costly procedures. "Ownership" of these protocols by a small team of surgeons, anesthetists, physiotherapists and nursing staff is the most important requirement for success.

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Conflict of Interest

There are no conflicts of interest.

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REFERENCES

1. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. Br J Anaesth. 1997 May;78(5):606-17. doi: 10.1093/bja/78.5.606. PMID: 9175983
2. Bardram L, Funch-Jensen P, Jensen P, Crawford ME, Kehlet H. Recovery after laparoscopic colonic surgery with epidural analgesia, and early oral nutrition and mobilisation. Lancet. 1995 Mar 25;345(8952):763-4. doi: 10.1016/s0140-6736(95)90643-6. PMID: 7891489
3. Parsley BS, Engh GA, Dwyer KA. Preoperative flexion. Does it influence postoperative flexion after posterior-cruciate-retaining total knee arthroplasty? Clin Orthop Relat Res. 1992 Feb;(275):204-10. PMID: 1735215
4. Köksal İ, Tahta M, Şimşek ME, Doğan M, Bozkurt M. Efficacy of rapid recovery protocol for total knee arthroplasty: a retrospective study. Acta Orthop Traumatol Turc. 2015;49(4):382-6. doi: 10.3944/AOTT.2015.14.0353. PMID: 26312464
5. Rutherford RW, Jennings JM, Dennis DA. Enhancing Recovery After Total Knee Arthroplasty. Orthop Clin North Am. 2017 Oct;48(4):391-400. doi: 10.1016/j.ocl.2017.05.002. Epub 2017 Aug 8. PMID: 28870300
6. Ayalon O, Liu S, Flics S, Cahill J, Juliano K, Cornell CN. A multimodal clinical pathway can reduce length of stay after total knee arthroplasty. HSS J. 2011 Feb;7(1):9-15. doi: 10.1007/s11420-010-9164-1. Epub 2010 May 22. PMID: 22294952; PMCID: PMC3026109
7. den Hertog A, Gliesche K, Timm J, Mühlbauer B, Zebrowski S. Pathway-controlled fast-track rehabilitation after total knee arthroplasty: a randomized prospective clinical study evaluating the recovery pattern, drug consumption, and length of stay. Arch Orthop Trauma Surg. 2012 Aug;132(8):1153-63. doi: 10.1007/s00402-012-1528-1. Epub 2012 May 27. PMID: 22643801; PMCID: PMC3400756
8. Gulotta LV, Padgett DE, Sculco TP, Urban M, Lyman S, Nestor BJ. Fast Track THR: One Hospital's Experience with a 2-Day Length of Stay Protocol for Total Hip Replacement. HSS J. 2011 Oct;7(3):223-8. doi: 10.1007/s11420-011-9207-2. Epub 2011 Jul 2. PMID: 22084624; PMCID: PMC3192891
9. Malviya A, Martin K, Harper I, Muller SD, Emmerson KP, Partington PF, Reed MR. Enhanced recovery program for hip and knee replacement reduces death rate. Acta Orthop. 2011 Oct;82(5):577-81. doi: 10.3109/17453674.2011.618911. Epub 2011 Sep 6. PMID: 21895500; PMCID: PMC3242954
10. McDonald DA, Siegmeth R, Deakin AH, Kinninmonth AW, Scott NB. An enhanced recovery programme for primary total knee arthroplasty in the United Kingdom--follow up at one year. Knee. 2012 Oct;19(5):525-9. doi: 10.1016/j.knee.2011.07.012. Epub 2011 Aug 30. PMID: 21880493
11. Raphael M, Jaeger M, van Vlymen J. Easily adoptable total joint arthroplasty program allows discharge home in two days. Can J Anaesth. 2011 Oct;58(10):902-10. doi: 10.1007/s12630-011-9565-8. Epub 2011 Aug 6. PMID: 21822756
12. Ghomrawi HM, Franco Ferrando N, Mandl LA, Do H, Noor N, Gonzalez Della Valle A. How Often are Patient and Surgeon Recovery Expectations for Total Joint Arthroplasty Aligned? Results of a Pilot Study. HSS J. 2011 Oct;7(3):229-34. doi: 10.1007/s11420-011-9203-6. Epub 2011 Jun 25. PMID: 23024618; PMCID: PMC3192888
13. Bozic KJ, Belkora J, Chan V, Youm J, Zhou T, Dupaix J, Bye AN, Braddock CH 3rd, Chenok KE, Huddleston JI 3rd. Shared decision making in patients with osteoarthritis of the hip and knee: results of a randomized controlled trial. J Bone Joint Surg Am. 2013 Sep 18;95(18):1633-9. doi: 10.2106/JBJS.M.00004. PMID: 24048550
14. Jourdan C, Poiraudeau S, Descamps S, Nizard R, Hamadouche M, Anract P, Boisgard S, Galvin M, Ravaud P. Comparison of patient and surgeon expectations of total hip arthroplasty. PLoS One. 2012;7(1):e30195. doi: 10.1371/journal.pone.0030195. Epub 2012 Jan 17. PMID: 22272303; PMCID: PMC3260245

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15. Moulton LS, Evans PA, Starks I, Smith T. Pre-operative education prior to elective hip arthroplasty surgery improves postoperative outcome. Int Orthop. 2015 Aug;39(8):1483-6. doi: 10.1007/s00264-015-2754-2. Epub 2015 Apr 11. PMID: 25862634
16. Gwynne-Jones DP, Martin G, Crane C. Enhanced Recovery After Surgery for Hip and Knee Replacements. Orthop Nurs. 2017 May/Jun;36(3):203-210. doi: 10.1097/NOR.0000000000000351. PMID: 28538534
17. Meehan J, Jamali AA, Nguyen H. Prophylactic antibiotics in hip and knee arthroplasty. J Bone Joint Surg Am. 2009 Oct;91(10):2480-90. doi: 10.2106/JBJS.H.01219. PMID: 19797586
18. Parvizi J, Gehrke T, Chen AF. Proceedings of the International Consensus on Periprosthetic Joint Infection. Bone Joint J. 2013 Nov;95-B(11):1450-2. doi: 10.1302/0301-620X.95B11.33135. PMID: 24151261
19. Turcotte JJ, Stone AH, Gilmor RJ, Formica JW, King PJ. The Effect of Neuraxial Anesthesia on Postoperative Outcomes in Total Joint Arthroplasty With Rapid Recovery Protocols. J Arthroplasty. 2020 Apr;35(4):950-954. doi: 10.1016/j.arth.2019.11.037. Epub 2019 Nov 29. PMID: 31883826
20. Stambough JB, Bloom GB, Edwards PK, Mehaffey GR, Barnes CL, Mears SC. Rapid Recovery After Total Joint Arthroplasty Using General Anesthesia. J Arthroplasty. 2019 Sep;34(9):1889-1896. doi: 10.1016/j.arth.2019.04.066. Epub 2019 May 9. PMID: 31202638
21. Yue C, Wei R, Liu Y. Perioperative systemic steroid for rapid recovery in total knee and hip arthroplasty: a systematic review and meta-analysis of randomized trials. J Orthop Surg Res. 2017 Jun 27;12(1):100. doi: 10.1186/s13018-017-0601-4. PMID: 28655354; PMCID: PMC5488481
22. Sambandam B, Batra S, Gupta R, Agrawal N. Blood conservation strategies in orthopedic surgeries: A review. J Clin Orthop Trauma. 2013 Dec;4(4):164-70. doi: 10.1016/j.jcot.2013.11.002. Epub 2013 Dec 8. PMID: 26403876; PMCID: PMC3880946
23. Zhang YM, Yang B, Sun XD, Zhang Z. Combined intravenous and intra-articular tranexamic acid administration in total knee arthroplasty for preventing blood loss and hyperfibrinolysis: A randomized controlled trial. Medicine (Baltimore). 2019 Feb;98(7):e14458. doi: 10.1097/MD.0000000000014458. Erratum in: Medicine (Baltimore). 2019 Mar;98(12):e15000. PMID: 30762760; PMCID: PMC6408055
24. Dennis DA, Kittelson AJ, Yang CC, Miner TM, Kim RH, Stevens-Lapsley JE. Does Tourniquet Use in TKA Affect Recovery of Lower Extremity Strength and Function? A Randomized Trial. Clin Orthop Relat Res. 2016 Jan;474(1):69-77. doi: 10.1007/s11999-015-4393-8. PMID: 26100254; PMCID: PMC4686529
25. Ziemba-Davis M, Nielson M, Kraus K, Duncan N, Nayyar N, Meneghini RM. Identifiable Risk Factors to Minimize Postoperative Urinary Retention in Modern Outpatient Rapid Recovery Total Joint Arthroplasty. J Arthroplasty. 2019 Jul;34(7S):S343-S347. doi: 10.1016/j.arth.2019.03.015. Epub 2019 Mar 12. PMID: 30956046
26. Sun X, Zhu X, Zeng Y, Zhang H, Zeng J, Feng W, Li J, Zeng Y. The effect of posterior capsule repair in total hip arthroplasty: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2020 Apr 21;21(1):263. doi: 10.1186/s12891-020-03244-y. PMID: 32316961; PMCID: PMC7175585
27. Adams CT, O'Leary RE, Gheewala RA, Roberts JT. Evolving Patient Perception of Limb Length Discrepancy Following Total Hip Arthroplasty. J Arthroplasty. 2021 Jul;36(7S):S374-S379. doi: 10.1016/j.arth.2021.02.080. Epub 2021 Mar 5. PMID: 33812717
28. Steere JT, Sobieraj MC, DeFrancesco CJ, Israelite CL, Nelson CL, Kamath AF. Prophylactic Tibial Stem Fixation in the Obese: Comparative Early Results in Primary Total Knee Arthroplasty. Knee Surg Relat Res. 2018 Sep 1;30(3):227-233. doi: 10.5792/ksrr.18.022. PMID: 30157590; PMCID: PMC6122940.
29. Bourazani M, Asimakopoulou E, Magklari C,

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Fyrfiris N, Tsirikas I, Diakoumis G, Kelesi M, Fasoi G, Kormas T, Lefaki G. Developing an enhanced recovery after surgery program for oncology patients who undergo hip or knee reconstruction surgery. World J Orthop. 2021 Jun 18;12(6):346-359. doi: 10.5312/wjo.v12.i6.346. PMID: 34189073; PMCID: PMC8223725

30. Maheshwari AV, Blum YC, Shekhar L, Ranawat AS, Ranawat CS. Multimodal pain management after total hip and knee arthroplasty at the Ranawat Orthopaedic Center. Clin Orthop Relat Res. 2009 Jun;467(6):1418-23. doi: 10.1007/s11999-009-0728-7. Epub 2009 Feb 13. PMID: 19214642; PMCID: PMC2674168
31. Bernaus M, Novellas M, Bartra A, Núñez JH, Anglès F. Local infiltration analgesia does not have benefits in fast-track hip arthroplasty programmes: a double-blind, randomised, placebo-controlled, clinical trial. Hip Int. 2021 Feb 18:1120700021992684. doi: 10.1177/1120700021992684. Epub ahead of print. PMID: 33601948
32. Cuenca-Llavall M, Pérez-Prieto D, Santiveri FJ, Garcia AL, Marqués F. The influence of local infiltration analgesia after total hip replacement. A randomized clinical trial. Acta Orthop Belg. 2020 Mar;86(1):33-37. PMID: 32490771
33. Nassar I, Fahey J, Mitchell D. Rapid recovery following hip and knee arthroplasty using local infiltration analgesia: length of stay, rehabilitation protocol and cost savings. ANZ J Surg. 2020 Mar;90(3):355-359. doi: 10.1111/ans.15663. Epub 2020 Jan 20. PMID: 31957218; PMCID: PMC7079075
34. Zhang Q, Liu L, Sun W, Gao F, Zhang Q, Cheng L, Li Z. Are closed suction drains necessary for primary total knee arthroplasty?: A systematic review and meta-analysis. Medicine (Baltimore). 2018 Jul;97(30):e11290. doi: 10.1097/MD.0000000000011290. PMID: 30045254; PMCID: PMC6078767
35. Quinn M, Bowe A, Galvin R, Dawson P, O'Byrne J. The use of postoperative suction drainage in total knee arthroplasty: a systematic review. Int Orthop. 2015 Apr;39(4):653-8. doi: 10.1007/s00264-014-2455-2. Epub 2014 Jul 16. PMID: 25027980
36. Esnaola NF, Cole DJ. Perioperative normothermia during major surgery: is it important? Adv Surg. 2011;45:249-63. doi: 10.1016/j.yasu.2011.03.007. PMID: 21954692
37. Sagiroglu G, Ozturk GA, Baysal A, Turan FN. Inadvertent Perioperative Hypothermia and Important Risk Factors during Major Abdominal Surgeries. J Coll Physicians Surg Pak. 2020 Feb;30(2):123-128. doi: 10.29271/jcpsp.2020.02.123. PMID: 32036816
38. Tayrose G, Newman D, Slover J, Jaffe F, Hunter T, Bosco J 3rd. Rapid mobilization decreases length-of-stay in joint replacement patients. Bull Hosp Jt Dis (2013). 2013;71(3):222-6. PMID: 24151950
39. Markert SE. The use of cryotherapy after a total knee replacement: a literature review. Orthop Nurs. 2011 Jan-Feb;30(1):29-36. doi: 10.1097/NOR.0b013e318205749a. PMID: 21278552
40. Chaudhry YP, MacMahon A, Rao SS, Mekkawy KL, Toci GR, Oni JK, Sterling RS, Khanuja HS. Predictors and Outcomes of Postoperative Hemoglobin of <8 g/dL in Total Joint Arthroplasty. J Bone Joint Surg Am. 2021 Oct 12. doi: 10.2106/JBJS.20.01766. Epub ahead of print. PMID: 34637406
41. Lieberman JR, Bell JA. Venous Thromboembolic Prophylaxis After Total Hip and Knee Arthroplasty. J Bone Joint Surg Am. 2021 Aug 18;103(16):1556-1564. doi: 10.2106/JBJS.20.02250. PMID: 34133395
42. Kay RD, Taylor AJ, Tye EY, Bryman JA, Runner RP. Outpatient Total Hip and Knee Arthroplasty Performed in a Safety Net Hospital System. J Am Acad Orthop Surg Glob Res Rev. 2021 Sep 16;5(9):e21.00117. doi: 10.5435/JAAOSGlobal-D-21-00117. PMID: 34529633; PMCID: PMC8448074
43. Rozell JC, Ast MP, Jiranek WA, Kim RH, Della Valle CJ. Outpatient Total Joint Arthroplasty: The New Reality. J Arthroplasty. 2021 Jul;36(7S):S33-S39. doi: 10.1016/j.arth.2021.02.030. Epub 2021 Feb 12.

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PMID: 33653629

44. Kee JR, Edwards PK, Barnes CL, Foster SE, Mears SC. After-Hours Calls in a Joint Replacement Practice. J Arthroplasty. 2019 Jul;34(7):1303-1306. doi: 10.1016/j.arth.2019.02.067. Epub 2019 Mar 8. PMID: 30956045
45. Kiss H, Raffl M, Neumann D, Hutter J, Dorn U. Epinephrine-augmented hypotensive epidural anesthesia replaces tourniquet use in total knee replacement. Clin Orthop Relat Res. 2005 Jul;(436):184-9. doi: 10.1097/01.blo.0000161825.90633.12. PMID: 15995439
46. Juelsgaard P, Larsen UT, Sørensen JV, Madsen F, Søballe K. Hypotensive epidural anesthesia in total knee replacement without tourniquet: reduced blood loss and transfusion. Reg Anesth Pain Med. 2001 Mar-Apr;26(2):105-10. doi: 10.1053/rapm.2001.21094. PMID: 11251132
47. Harsten A, Bandholm T, Kehlet H, Toksvig-Larsen S. Tourniquet versus no tourniquet on knee-extension strength early after fast-track total knee arthroplasty; a randomized controlled trial. Knee. 2015 Mar;22(2):126-30. doi: 10.1016/j.knee.2014.12.010. Epub 2014 Dec 31. PMID: 25648580
48. Yang G, Chen W, Chen W, Tang X, Huang Y, Zhang L. Feasibility and Safety of 2-Day Discharge After Fast-Track Total Hip Arthroplasty: A Chinese Experience. J Arthroplasty. 2016 Aug;31(8):1686-1692.e1. doi: 10.1016/j.arth.2016.02.011. Epub 2016 Feb 17. PMID: 26968693
49. Hansen TB. Fast track in hip arthroplasty. EFORT Open Rev. 2017 May 11;2(5):179-188. doi: 10.1302/2058-5241.2.160060. PMID: 28630756; PMCID: PMC5467651
50. Kehlet H, Andersen LØ. Local infiltration analgesia in joint replacement: the evidence and recommendations for clinical practice. Acta Anaesthesiol Scand. 2011 Aug;55(7):778-84. doi: 10.1111/j.1399-6576.2011.02429.x. Epub 2011 Apr 4. PMID: 21463261
51. Andersen LØ, Kehlet H. Analgesic efficacy of local infiltration analgesia in hip and knee arthroplasty: a systematic review. Br J Anaesth. 2014 Sep;113(3):360-74. doi: 10.1093/bja/aeu155. Epub 2014 Jun 17. PMID: 24939863
52. Kaye AD, Urman RD, Cornett EM, Hart BM, Chami A, Gayle JA, Fox CJ. Enhanced recovery pathways in orthopedic surgery. J Anaesthesiol Clin Pharmacol. 2019 Apr;35(Suppl 1):S35-S39. doi: 10.4103/joacp.JOACP_35_18. PMID: 31142957; PMCID: PMC6515716

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Avramidis E, Zafeiris E, Sakkas A, Vergados N, Tyrpenou E, Grigoropoulou I, Dinic M, Remoundou M, Grammatikos G, Babis GC. Rapid recovery protocol after Total Hip and Knee Arthroplasty that is safe and effective in most clinical environments. *Acta Orthop Trauma Hell* 2022; 73(1): 60-68.