ISAKOS CONGRESS 2025 | MUNICH GERMANY June 8–11

Higher Preoperative Knee Extensor Strength Could Be Beneficial In Reducing Total Blood Loss In Total Knee Arthroplasty

Seong-Hwan Kim[1], M.D., Yong-Beom Park[2], M.D

Chung-Ang University Hospital, Seoul, Republic of Korea[1]

Chung-Ang University Hospital Gwangmyeong Hospital[2], Gwangmyeong-Si, Gyeonggi-Do, Republic of Korea[2]

Faculty Disclosure Information

- Nothing to disclosure…

Introduction

❖ Intraoperative blood loss is one of the major risks of surgical procedure

- Critical to accelerating patients' post operative recovery, post operative function.

❖ Previous study suggests tourniquet application, intraoperative tranexamic acid(TXA) to reduce intraoperative blood loss

- Few studies report whether preoperative lower-limb muscle strength condition affect intraoperative blood loss in TKA→ **Controversial**

Aim of study

❖ **To assess the effect of preoperative lower-limb extensor strength on total blood loss, preoperative and POD1 knee pain and function**

Material and Method

❖ Retrospective study

- Involved 115 patients scheduled for TKA from February 2022 to March 2023
- Based on the presence of sarcopenia, all patients were divided into normal(n=87) and sarcopenia group(n=28)

❖ Preoperative isokinetic muscle strength(IMS) by Biodex

❖ Total blood loss = $\frac{EBV\ (Hct_0 - Hct_f)}{Hct_{AV}}$

Hct_0 = hematocrit before surgery; Hct_f = hematocrit after surgery

Hct_{AV} = (hematocrit before surgery + hematocrit after surgery) / 2

Material and Method

❖ Sarcopenia(defined by Asian Working group for Sarcopenia(AWGS))

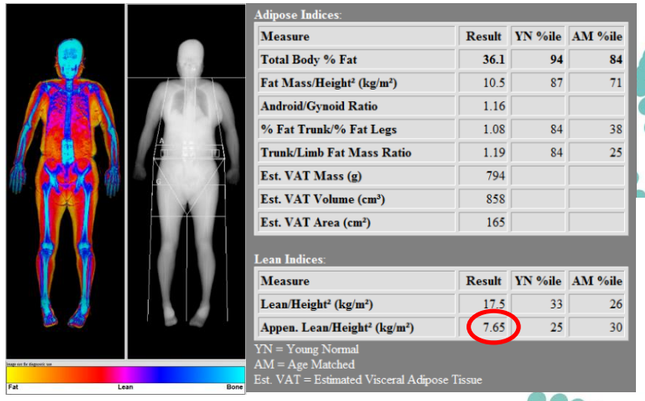
(1) Muscle strength(Hand grip strength)

Male <28kg
Female <18kg

(2) Physical performance test

- 6-meter walk <1.0m/s
- OR 5-time chair stand test >12sec
- OR Short Physical Performance battery <9

(3) Muscle mass(Whole body dexa)



Adipose Indices:

Measure	Result	YN %ile	AM %ile
Total Body % Fat	36.1	94	84
Fat Mass/Height² (kg/m²)	10.5	87	71
Android/Gynoid Ratio	1.16		
% Fat Trunk/% Fat Legs	1.08	84	38
Trunk/Limb Fat Mass Ratio	1.19	84	25
Est. VAT Mass (g)	794		
Est. VAT Volume (cm³)	858		
Est. VAT Area (cm²)	165		

Lean Indices:

Measure	Result	YN %ile	AM %ile
Lean/Height² (kg/m²)	17.5	33	26
Appen. Lean/Height² (kg/m²)	7.65	25	30

YN = Young Normal
AM = Age Matched
Est. VAT = Estimated Visceral Adipose Tissue

Male < 7.0 kg/m²
Female < 5.4 kg/m²

Sarcopenia

Low ASM + low muscle strength
OR Low physical performance

Results

- **TBL** : Sarcopenia group > Normal group
- **Postoperative ROM** : Sarcopenia group < Normal group
- **Postoperative pain** : Sarcopenia group > Normal group
- **Physical performance** : Sarcopenia group < Normal group

Results

Table 1. Basic characteristics of TKA patients

	No sarcopenia Group (n=87)	Sarcopenia Group (n=28)	*P*
Female/Male, n	82/5	26/2	-
Age, Mean (SD)- years	70.9 (5.5)	71.4 (6.0)	***n.s***
BMI, Mean (SD)-kg/m^2	26.5 (2.8)	23.2 (3.1)	***0.005***
ASA classification, II/III	73/14	24/4	***n.s***
LOS, Mean (SD)-Day	6.0 (1.4)	6.7 (1.0)	***n.s***
Extensor Torque at 60 degree (N.m)	71.4(12.4)	51.8(15.4)	***0.000***
Grip strength (kg)	15.8 (7.8)	12.2 (4.3)	***0.000***
Abnormal physical performance test (n)	57 (65.5%)	28 (100%)	***0.000***
Whole body Dexa (APM, kg/m^2)	5.8 (3.4)	4.9(5.2)	***0.000***

TKA: total knee arthroplasty, BMI: body mass index; ASA: American Society of Anesthesiologists; LOS: length of hospital stay.

Data were analyzed using the *Mann-Whitney U* test, unless otherwise noted.

Results

Table 2. Comparison of measurements between the sarcopenia and normal groups after TKA.

	No sarcopenia Group (n=87)	Sarcopenia Group (n=28)	*P*
TBL, Mean (SD)-ml	534.5 (105.0)	635.9 (142.4)	***0.000***
Homologous Transfusion, n (%)	4 (4.6)	2 (7.1)	*0.179*
POD7 Values			
Hct, Mean (SD)-%	36.7 (3.8)	34.5 (3.5)	***0.007***
Hb, Mean (SD)-g/L	119.3 (5.3)	117.0 (5.1)	***0.046***
Hct Loss, Mean (SD)-%	5.5 (1.2)	6.5 (1.4)	***0.000***
Hb Loss, Mean (SD)-g/L	17.1 (8.5)	17.6 (8.4)	*0.780*
POD7 Pain and Function			
VAS, Mean (SD)	3.9 (0.7)	4.3 (0.6)	***0.007***
Knee ROM, Mean (SD)-degree	95.8 (5.4)	85.8 (3.8)	***0.000***

TKA: total knee arthroplasty; TBL: total blood loss; POD7: postoperative day 7; Hct: Hematocrit; Hb: Hemoglobin; VAS: visual analog scale; ROM: active range of motion.

Summary

- Patients extensor strength was found significantly lower in sarcopenia group.
- Compared to normal group, the sarcopenia group had lower TBL, greater postoperative ROM, less postoperative pain, better physical performance results.

Conclusion

- **Patients with sarcopenia were found higher total blood loss and lower functional outcomes in early period after TKA.**

- **In preoperative preparation for TKA, knee extensor muscle strength is important.**

References

1. Smilowitz NR, Oberweis BS, Nukala S, Rosenberg A, Zhao S, Xu J, Stuchin S, Iorio R, Errico T, Radford MJ et al: Association Between Anemia, Bleeding, and Transfusion with Long-term Mortality Following Noncardiac Surgery. Am J Med 2016, 129(3):315-323.e312.
2. Liu X, Zhang X, Chen Y, Wang Q, Jiang Y, Zeng B: Hidden blood loss after total hip arthroplasty. J Arthroplasty 2011, 26(7):1100-1105.e1101.
3. Lasocki S, Krauspe R, von Heymann C, Mezzacasa A, Chainey S, Spahn DR: PREPARE: the prevalence of perioperative anaemia and need for patient blood management in elective orthopaedic surgery: a multicentre, observational study. Eur J Anaesthesiol 2015, 32(3):160-167.
4. Frew N, Alexander D, Hood J, Acornley A: Impact of a blood management protocol on transfusion rates and outcomes following total hip and knee arthroplasty. Ann R Coll Surg Engl 2016, 98(6):380-386.
5. Spahn DR: Anemia and patient blood management in hip and knee surgery: a systematic review of the literature. Anesthesiology 2010, 113(2):482-495.
6. Musallam KM, Tamim HM, Richards T, Spahn DR, Rosendaal FR, Habbal A, Khreiss M, Dahdaleh FS, Khavandi K, Sfeir PM et al: Preoperative anaemia and postoperative outcomes in non-cardiac surgery: a retrospective cohort study. Lancet 2011, 378(9800):1396-1407.
7. Price AJ, Alvand A, Troelsen A, Katz JN, Hooper G, Gray A, Carr A, Beard D: Knee replacement. Lancet 2018, 392(10158):1672-1682.
8. Chen TP, Chen YM, Jiao JB, Wang YF, Qian LG, Guo Z, Ma Z, Han CY, Shi TH: Comparison of the effectiveness and safety of topical versus intravenous tranexamic acid in primary total knee arthroplasty: a meta-analysis of randomized controlled trials. J Orthop Surg Res 2017, 12(1):11.
9. Wainwright TW, Gill M, McDonald DA, Middleton RG, Reed M, Sahota O, Yates P, Ljungqvist O: Consensus statement for perioperative care in total hip replacement and total knee replacement surgery: Enhanced Recovery After Surgery (ERAS(®)) Society recommendations. Acta Orthop 2020, 91(1):3-19.
10. Chen S, Li J, Peng H, Zhou J, Fang H, Zheng H: The influence of a half-course tourniquet strategy on peri-operative blood loss and early functional recovery in primary total knee arthroplasty. Int Orthop 2014, 38(2):355-359.
11. Horlocker TT, Hebl JR, Gali B, Jankowski CJ, Burkle CM, Berry DJ, Zepeda FA, Stevens SR, Schroeder DR: Anesthetic, patient, and surgical risk factors for neurologic complications after prolonged total tourniquet time during total knee arthroplasty. Anesth Analg 2006, 102(3):950-955.
12. Stocks GW, Odoemene M, Gex J, Vidal EA, Sawyer K, Jones SL, Thompson B, Laughlin MS: Quadriceps Strain and TKA: Contribution of the Tourniquet and Intramedullary Rod to Postoperative Thigh Pain: A Randomized Controlled Trial. J Bone Joint Surg Am 2023, 105(6):455-461.
13. 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, 474(1):69-77.
14. Hsu LI, Hsu HW, Chen JW, Wei ST, Hou SM: The safety of tranexamic acid administration in total knee arthroplasty: a population-based study from Taiwan. Anaesthesia 2023, 78(3):303-314.
15. Domínguez-Navarro F, Silvestre-Muñoz A, Igual-Camacho C, Díaz-Díaz B, Torrella JV, Rodrigo J, Payá-Rubio A, Roig-Casasús S, Blasco JM: A randomized controlled trial assessing the effects of preoperative strengthening plus balance training on balance and functional outcome up to 1 year following total knee replacement. Knee Surg Sports Traumatol Arthrosc 2021, 29(3):838-848.
16. Zhu L, Ye T, Tang Q, Wang Y, Wu X, Li H, Jiang Y: Exercise Preconditioning Regulates the Toll-Like Receptor 4/Nuclear Factor-κB Signaling Pathway and Reduces Cerebral Ischemia/Reperfusion Inflammatory Injury: A Study in Rats. J Stroke Cerebrovasc Dis 2016, 25(11):2770-2779.
17. Gross JB: Estimating allowable blood loss: corrected for dilution. Anesthesiology 1983, 58(3):277-280.
18. Nadler SB, Hidalgo JH, Bloch T: Prediction of blood volume in normal human adults. Surgery 1962, 51(2):224-232.
19. Sharma L, Dunlop DD, Cahue S, Song J, Hayes KW: Quadriceps strength and osteoarthritis progression in malaligned and lax knees. Ann Intern Med 2003, 138(8):613-619.
20. Li M, Nie Y, Li K, Zeng Y, Wu Y, Liu Y, Wu L, Shen B: Effect of Extensor Muscle Strength on Meniscus Damage Progression in Subjects Without Radiologic Knee Osteoarthritis: Data From the Osteoarthritis Initiative. Am J Phys Med Rehabil 2022, 101(9):836-842.
21. Naziri Q, Issa K, Malkani AL, Bonutti PM, Harwin SF, Mont MA: Bariatric orthopaedics: total knee arthroplasty in super-obese patients (BMI > 50 kg/m2). Survivorship and complications. Clin Orthop Relat Res 2013, 471(11):3523-3530.
22. Krauss ES, Cronin M, Dengler N, Simonson BG, Altner K, Daly M, Segal A: The Effect of BMI and Gender on Bleeding Events when Rivaroxaban Is Administered for Thromboprophylaxis Following Total Hip and Total Knee Arthroplasty. Semin Thromb Hemost 2019, 45(2):180-186.
23. Perkisas S, De Cock AM, Verhoeven V, Vandewoude M: Intramuscular Adipose Tissue and the Functional Components of Sarcopenia in Hospitalized Geriatric Patients. Geriatrics (Basel) 2017, 2(1).
24. Barazzoni R, Bischoff SC, Boirie Y, Busetto L, Cederholm T, Dicker D, Toplak H, Van Gossum A, Yumuk V, Vettor R: Sarcopenic obesity: Time to meet the challenge. Clin Nutr 2018, 37(6 Pt A):1787-1793.
25. Knight K, Knight KL, Draper DO: Therapeutic modalities: the art and science: Lippincott Williams & Wilkins; 2012.
26. Aplin AC, Nicosia RF: Tissue oxygenation stabilizes neovessels and mitigates hemorrhages in human atherosclerosis-induced angiogenesis. Angiogenesis 2023, 26(1):63-76.
27. de Vries MR, Parma L, Peters HAB, Schepers A, Hamming JF, Jukema JW, Goumans M, Guo L, Finn AV, Virmani R et al: Blockade of vascular endothelial growth factor receptor 2 inhibits intraplaque haemorrhage by normalization of plaque neovessels. J Intern Med 2019, 285(1):59-74.
28. Hiyama Y, Kamitani T, Wada O, Mizuno K, Yamada M: Effects of Group-Based Exercise on Range of Motion, Muscle Strength, Functional Ability, and Pain During the Acute Phase After Total Knee Arthroplasty: A Controlled Clinical Trial. J Orthop Sports Phys Ther 2016, 46(9):742-748.
29. Mizner RL, Petterson SC, Stevens JE, Axe MJ, Snyder-Mackler L: Preoperative quadriceps strength predicts functional ability one year after total knee arthroplasty. J Rheumatol 2005, 32(8):1533-1539.
30. Al-Sayyad MJ, Cameron JC: Functional outcome after tibial tubercle transfer for the painful patella alta. Clinical Orthopaedics and Related Research (1976-2007) 2002, 396:152-162.
31. Mizner RL, Petterson SC, Snyder-Mackler L: Quadriceps strength and the time course of functional recovery after total knee arthroplasty. J Orthop Sports Phys Ther 2005, 35(7):424-436.
32. Zhao HY, Yeersheng R, Kang XW, Xia YY, Kang PD, Wang WJ: The effect of tourniquet uses on total blood loss, early function, and pain after primary total knee arthroplasty: a prospective, randomized controlled trial. Bone Joint Res 2020, 9(6):322-332.
33. Liu W, Yang C, Huang X, Liu R: Tranexamic Acid Reduces Occult Blood Loss, Blood Transfusion, and Improves Recovery of Knee Function after Total Knee Arthroplasty: A Comparative Study. J Knee Surg 2018, 31(3):239-246.
34. Lord SR, Murray SM, Chapman K, Munro B, Tiedemann A: Sit-to-Stand Performance Depends on Sensation, Speed, Balance, and Psychological Status in Addition to Strength in Older People. The Journals of Gerontology: Series A 2002, 57(8):M539-M543.