

AORN Guideline for Pneumatic Tourniquet Safety
Evidence Table

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
1	Boya H, Tuncali B, Özcan Ö, Araç Ş, Tuncay C. Practice of tourniquet use in Turkey: a pilot study. Acta Orthop Traumatol Turc. 2016;50(2):162-170.	Qualitative	98 surgeons	n/a	n/a	18 questions approved by authors (application 12, use 6)	Found surgeons mostly consistent with literature for pneumatic tourniquet time & safe application, but not for pressure parameters.	IIIB
2	Shah FA, Mahmood K, Din SU, Mehsod WM, Qureshi AR, Babar IU. A survey of tourniquet use in limbs surgery among the orthopaedic surgeons of Peshawar. Pak J Med Health Sci. 2014;8(3):523-526.	Qualitative	44 respondents, 3 years of post fellowship experience in private or government hospitals in Peshawar	n/a	n/a	17 questions constructed from AORN guideline	Suboptimal knowledge & variation in settings & techniques found.	IIIC
3	Cunningham L, McCarthy T, O'Byrne J. A survey of upper and lower limb tourniquet use among Irish orthopaedic surgeons. Ir J Med Sci. 2013;182(3):325-330.	Qualitative	92 orthopedic surgeons	n/a	n/a	15 question survey, author-derived	Lack of consensus needs further research, stated pressures used may be higher than necessary.	IIIB
4	Yalçinkaya M, Sökücü S, Erdoğan S, Kabukçuoğlu YS. Tourniquet use in orthopedic surgery: a descriptive survey study among Turkish orthopedic surgeons and residents in Istanbul. Acta Orthop Traumatol Turc. 2014;48(5):483-490.	Qualitative	211 orthopedic surgeons	n/a	n/a	12 Questionnaire researcher-derived, face to face survey	Association between more years in practice & higher pressures used; conclude surgeons should review EBP of pneumatic tourniquet use.	IIIB
5	Daruwalla ZJ, Rowan F, Finnegan M, Fennell J, Neligan M. Exsanguinators and tourniquets: do we need to change our practice? Surgeon. 2012;10(3):137-142.	Nonexperimental	8 porters, 12 RN, 10 senior house officers, 38 registrars, 6 consultants; 10 pneumatic tourniquet & 10 Esmarch's	n/a	n/a	understanding of staff regarding exsanguination use & sterility; questionnaire & culture swab of tourniquets	RN received highest scores, all Esmarch's were contaminated but not pneumatic tourniquets.	IIIC
6	Yi S, Tan J, Chen C, Chen H, Huang W. The use of pneumatic tourniquet in total knee arthroplasty: a meta-analysis. Arch Orthop Trauma Surg. 2014;134(10):1469-1476.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	1995-2012 13 RCTs included; 859 patients, primary unilateral TKA. Pneumatic tourniquet use decreased operative time, intraoperative blood loss, but increased postop & total blood loss & complications (DVT & SSI).	IA
7	Jiang F, Zhong H, Hong YC, Zhao GF. Use of a tourniquet in total knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials. J Orthop Sci. 2015;20(1):110-123.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	1995 - 2012 26 RCTs included. Pneumatic tourniquet use decreased intraoperative blood loss, transfusion rate, & operative time, but also increased DVT & complications & slowed short-term recovery.	IA
8	Zhang W, Liu A, Hu D, Tan Y, Al-Aidaros M, Pan Z. Effects of the timing of tourniquet release in cemented total knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials. J Orthop Surg Res. 2014;9:125.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	1979- 2013 11 RCTs included; 651 patients. Decreased pneumatic tourniquet time could reduce complications, but concluded not enough evidence.	IA

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9	Pfitzner T, von Roth P, Voerkelius N, Mayr H, Perka C, Hube R. Influence of the tourniquet on tibial cement mantle thickness in primary total knee arthroplasty. <i>Knee Surg Sports Traumatol Arthrosc.</i> 2016;24(1):96-101.	RCT	90 pt	PT	no PT	cement mantle thickness, EBL, pain; measurements in 6 zones & cement mantle at tibial baseplate	No loosening of implant without pneumatic tourniquet use but increased EBL without pneumatic tourniquet.	IA
10	Li X, Yin L, Chen ZY, et al. The effect of tourniquet use in total knee arthroplasty: grading the evidence through an updated meta-analysis of randomized, controlled trials. <i>Eur J Orthop Surg Traumatol.</i> 2014;24(6):973-986.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Using pneumatic tourniquet does not reduce total EBL effectively, low quality, consider timing of deflation, DVT/pulmonary embolism concern with pneumatic tourniquet use.	IA
10	Li X, Yin L, Chen Z, et al. The effect of tourniquet use in total knee arthroplasty: Grading the evidence through an updated meta-analysis of randomized, controlled trials. <i>Eur j orthop surg traumatol .</i> 2014;24(6):973-986.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	1995-2012 15 RCTs included; 804 TKA with or without PT. Pneumatic tourniquet use decreased intraoperative blood loss, increased postop blood loss, but had no difference on calculated blood loss, operative time, or complications, however GRADE score was too low to make recommendations.	IA
11	Kumar K, Railton C, Tawfic Q. Tourniquet application during anesthesia: "what we need to know?" <i>J Anaesthesiol Clin Pharmacol.</i> 2016;32(4):424-430.	Literature Review	n/a	n/a	n/a	n/a	Concludes there are no absolute contraindications for tourniquet use, but use caution in patients diagnosed with peripheral vascular disease, sickle cell disorder, diabetic neuropathy, or DVT, or with crushing injuries.	VA
12	Ducic I, Chang S, Dellon AL. Use of the tourniquet in reconstructive surgery in patients with previous ipsilateral lower extremity revascularization: is it safe? A survey. <i>J Reconstr Microsurg.</i> 2006;22(3):183-189.	Qualitative	28 vascular surgeons	n/a	n/a	Pneumatic tourniquet use in previously revascularized lower extremity - possible complication graft failure	93% reported it was inappropriate to use pneumatic tourniquet on previous revascularized extremity, 71% reported the same for an angioplasty, however there is a lack of RCT to study complications; concluded to avoid pneumatic tourniquet use.	IIIC
13	McMillan TE, Johnstone AJ. Tourniquet uses and precautions. <i>Surgery.</i> 2017;35(4):201-203.	Literature Review	n/a	n/a	n/a	n/a	Concludes contraindication decision is patient & case-specific & to limit inflation time.	VB
14	Ellanti P, Hurson C. Tourniquet-associated povidone-iodine-induced chemical burns. <i>BMJ Case Rep.</i> 2015;2015.	Case Report	n/a	n/a	n/a	n/a	Older male patient found chemical burn related to patient antiseptic solution; pain resolved postop day 4 & blisters resolved in 6 weeks.	VC

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15	Yang JH, Lim H, Yoon JR, Jeong HI. Tourniquet associated chemical burn. <i>Indian J Orthop.</i> 2012;46(3):356-359.	Case Report	n/a	n/a	n/a	n/a	Young male reported chemical burn; concluded to decrease friction by using caution to prevent the tourniquet moving during draping, using elastic stockinette padding, preventing cuff & leg-shape mismatch, & providing a physical barrier to fluid accumulation, which can prevent further issues.	VB
16	Supradeeptha C, Shandilya SM, Naresh A, Satyaprasad J. Aqueous based povidone-iodine related chemical burn under the tourniquet (a case report) and literature review. <i>J Orthop.</i> 2013;10(3):152-154.	Case Report	n/a	n/a	n/a	n/a	Chemical burn related to friction with elastic under cotton roll; recommend applying tourniquet with uniform thickness & decrease movement during draping, protect cuff from fluids.	VB
17	Chiang YC, Lin TS, Yeh MC. Povidone-iodine-related burn under the tourniquet of a child—a case report and literature review. <i>J Plast Reconstr Aesthet Surg.</i> 2011;64(3):412-415.	Case Report	n/a	n/a	n/a	n/a	Chemical burn related to pressure from PT, body, & solution on cuff that creates maceration, long operative time; pediatrics are more sensitive or history of skin disorders. Researchers recommend never abrading skin, don't allow solution to pool or trap under cuff, keep cuff dry, decrease operative & pneumatic tourniquet inflation time, & protect under the cuff by taping the distal end or using spray prep.	VC
18	Kindle BJ, Murthy N, Stolp K. Compartment syndrome with mononeuropathies following anterior cruciate ligament reconstruction. <i>Am J Phys Med Rehabil.</i> 2015;94(5):e37-e41.	Case Report	n/a	n/a	n/a	n/a	Multiple case reports concluded that tourniquet pressure >350 increases compressive neuropraxia & potential compartment syndrome risk.	VC
19	Mingo-Robinet J, Castañeda-Cabrero C, Alvarez V, León Alonso-Cortés JM, Monge-Casares E. Tourniquet-related iatrogenic femoral nerve palsy after knee surgery: case report and review of the literature. <i>Case Rep Orthop.</i> 2013;2013:368290.	Case Report	n/a	n/a	n/a	n/a	3 times the complications for every 30 minutes of inflation; however, others reported <2 hour or <300 mmHg still had complications.	VC
20	Santhosh MC, Pai RB, Rao RP. Acute pulmonary edema following inflation of arterial tourniquet. <i>Rev Esp Anesthesiol Reanim.</i> 2014;61(8):451-453.	Case Report	n/a	n/a	n/a	n/a	Inflation of the tourniquet lead to pulmonary edema in a young patient.	VA
21	Houng WR, Lee CL, Chiou HM, Wei YS. Cardiac arrest after tourniquet deflation in tibial plateau fracture surgery in a healthy man. <i>Formosan Journal of Musculoskeletal Disorders.</i> 2012;3(1):34-38.	Case Report	n/a	n/a	n/a	n/a	Cardiac arrest after 5 minutes of inflation in healthy male patient, recommend readjustment after 2 hours of pneumatic tourniquet inflation is >15 min, potential harm after >2 hour according to previous AORN guideline.	VB

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22	Desai S, Prashantha PG, Torgal SV, Rao R. Fatal pulmonary embolism subsequent to the use of Esmarch bandage and tourniquet: a case report and review of literature. Saudi J Anaesth. 2013;7(3):331-335.	Case Report	n/a	n/a	n/a	n/a	Mechanical stress of pneumatic tourniquet & Esmarch lead to pulmonary embolism; immediate diagnosis may lead to successful resuscitation, preop anticoagulation & diagnosis workup to prevent adverse event, estimate the risk of using an Esmarch & pneumatic tourniquet to avoid in high risk patients.	VB
23	Guideline for care of the patient receiving local anesthesia. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2020:447-442.	Guideline	n/a	n/a	n/a	n/a	Guidance on local anesthetics.	IVA
24	Guideline for team communication. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2020:1039-1070.	Guideline	n/a	n/a	n/a	n/a	Guidance on team communication as it relates to patient safety.	IVA
25	Zhang W, Li N, Chen S, Tan Y, Al-Aidaros M, Chen L. The effects of a tourniquet used in total knee arthroplasty: a meta-analysis. J Orthop Surg Res. 2014;9(1):13.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	13 RCTs included from 1995 - 2012; 689 pneumatic tourniquet, 689 knees. Pneumatic tourniquet use decreased intraoperative blood loss, decreased operative time but not clinically significant, significant decrease in postop range of motion, sign increased DVT & complications, with no difference in calculated blood loss or transfusion rate; use pneumatic tourniquet prudently.	IA
26	Præstegaard M, Beisvåg E, Erichsen JL, Brix M, Viberg B. Tourniquet use in lower limb fracture surgery: a systematic review and meta-analysis. Eur J Orthop Surg Traumatol. 2019;29(1):175-181.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	1991-2010 5 RCTs included in synthesis, 4 in meta-analysis. Pneumatic tourniquet associated with significantly higher postop pain & significantly more complications, concluded to limit to 2 hours, related to nerve & pressure injury risk; not cost effective to reduce minutes off operative time versus the increased length of stay & cost of pneumatic tourniquet use.	IB
27	Liu PL, Li DQ, Zhang YK, et al. Effects of unilateral tourniquet used in patients undergoing simultaneous bilateral total knee arthroplasty. Orthop Surg. 2017;9(2):180-185.	RCT	52 pt	PT	no PT	op time, pain, ROM, first straight leg, swell, wound healing, DVT, KSS	Pneumatic tourniquet associated with decreased operative time; no pneumatic tourniquet associated with less pain, time to straight-leg raise, swelling, & complications; no difference in range of motion, DVT, or Knee Society Score.	IB

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28	Stetzelberger V, Obertacke U, Jawhar A. Tourniquet application during TKA did not affect the accuracy of implant positioning: a randomized clinical trial. <i>Knee Surg Sports Traumatol Arthrosc.</i> 2018;26(6):1728-1736.	RCT	86 pt	no PT	PT	varus or valgus angle, joint line, distance of implant	No difference found; conclude risk of pneumatic tourniquet complications outweighed by no change in implant efficacy.	IA
29	Molt M, Harsten A, Toksvig-Larsen S. The effect of tourniquet use on fixation quality in cemented total knee arthroplasty a prospective randomized clinical controlled RSA trial. <i>Knee.</i> 2014;21(2):396-401.	RCT	60 pt	PT	no PT	radio stereometric analysis (RSA) of implant at 2-3 postop day, 3 months, 1 year, or 2 year	Similar implant stability between groups with this prosthesis.	IA
30	Ejaz A, Laursen AC, Kappel A, Jakobsen T, Nielsen PT, Rasmussen S. Tourniquet induced ischemia and changes in metabolism during TKA: a randomized study using microdialysis. <i>BMC Musculoskelet Disord.</i> 2015;16:326.	RCT	62 pt	no PT	PT	ischemic metabolites - glucose, pyruvate, lactate, glycerol, Lactate/Pyruvate ratio	Pneumatic tourniquet associated with increased ischemia.	IB
31	Nakayama H, Yoshiya S. The effect of tourniquet use on operative performance and early postoperative results of anatomic double-bundle anterior cruciate ligament reconstruction. <i>J Orthop Sci.</i> 2013;18(4):586-591.	RCT	51 pt	no PT	PT	field quality, operative time, suction drain blood loss, Hemoglobin decrease, swelling postop day 3, 5, & 2 week, 3 week, visual analog scale for numb & pain 6, quadricep & hamstring measures at 3 month	Not using pneumatic tourniquet was uneventful, but using pneumatic tourniquet increased postop bleeding & numbness.	IB
32	Ejaz A, Laursen AC, Kappel A, et al. Faster recovery without the use of a tourniquet in total knee arthroplasty. <i>Acta Orthop.</i> 2014;85(4):422-426.	RCT	70 pt TKA	pneumatic tourniquet at 250 mmHg after dressing	no PT	Knee Injury & Osteoarthritis Outcome Score & range of motion, EBL, time & visibility, pain, analgesic consumption, transfusion requirements	No pneumatic tourniquet group had faster recovery & decreased pain & analgesic use, but no difference in quality of field.	IA
33	Tsarouhas A, Hantes ME, Tsoungias G, Dailiana Z, Malizos KN. Tourniquet use does not affect rehabilitation, return to activities, and muscle damage after arthroscopic meniscectomy: a prospective randomized clinical study. <i>Arthroscopy.</i> 2012;28(12):1812-1818.	RCT	20 TKA	PT	no PT	Visual analog scale average of 4 points each day, drainage, transfusion, swelling, morphine, length of stay, range of motion, Oxford Knee Score, knee extension preoply, 6 week, 6, & 12 month	Operative time & Visual analog scale postop day 2 & 4 higher with PT, but transfusion higher with no PT; concluded there is no obvious disadvantage to not using PT.	IB

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34	Tsarouhas A, Hantes ME, Tsougias G, Dailiana Z, Malizos KN. Tourniquet use does not affect rehabilitation, return to activities, and muscle damage after arthroscopic meniscectomy: A prospective randomized clinical study. <i>Arthroscopy</i> . 2012;28(12):1812-1818	RCT	80 pt	PT	no PT	Visual analog scale pain, range of motion postop day 8 & 15, discontinue crutches, jogging, Creatine phosphokinase test preoply postop day 1,8, & 15	There was no difference in age, gender, Body Mass Index, preop International knee documentation committee scores & no difference in operative time, Visual analog scale, range of motion, not needing crutches, resuming activity, & Creatine phosphokinase levels; pneumatic tourniquet use does not delay rehab, researchers advocate for routine use, especially when surgeons are teaching.	IA
35	Drolet BC, Okhah Z, Phillips BZ, et al. Evidence for safe tourniquet use in 500 consecutive upper extremity procedures. <i>Hand (N Y)</i> . 2014;9(4):494-498.	Nonexperimental	505 pt	n/a	n/a	demographic, comorbidities, complications, pneumatic tourniquet parameters - application, pressure, time	No injuries reported, concluded that SBP+100 mmHg (<250 mmHg) pressure for 2 hour is safe.	IIIB
36	Horlocker TT, Hebl JR, Gali B, et al. Anesthetic, patient, and surgical risk factors for neurologic complications after prolonged total tourniquet time during total knee arthroplasty. <i>Anesth Analg</i> . 2006;102(3):950-955.	Nonexperimental	1001 pneumatic tourniquet>120 min PT	n/a	n/a	nerve injuries	Younger patients, increase pneumatic tourniquet time, preop flexion, & contractures increase risk nerve injury; over >180 min a longer reperfusion time decrease complication; complications increase with total pneumatic tourniquet time, reperfusion modestly decreased nerve injury risk; concluded there's 3x increase risk for injury for every 30 minutes pneumatic tourniquet inflation.	IIIA
37	Hoozeboom TJ, van Meeteren NL, Schank K, Kim RH, Miner T, Stevens-Lapsley JE. Risk factors for delayed inpatient functional recovery after total knee arthroplasty. <i>Biomed Res Int</i> . 2015;2015:167643.	Nonexperimental	193 TKA	n/a	n/a	age, sex, Body Mass Index, associated with inpatient functional recovery for TKA, evaluation of estimated blood loss (EBL), pneumatic tourniquet inflation time, morphine, surgeon's experience	Pneumatic tourniquet time did not significantly affect recovery time; patient-specific factors (age, sex, BMI) contribute more.	IIIB
38	Bailey AN, Hocker AD, Vermillion BR, et al. MAFbx, MuRF1, and the stress-activated protein kinases are upregulated in muscle cells during total knee arthroplasty. <i>Am J Physiol Regul Integr Comp Physiol</i> . 2012;303(4):R376-R386.	Nonexperimental	12 TKA	n/a	n/a	measure Forkhead box O3 , stress-activated protein kinases during TKA	Down regulation of serine/threonine protein kinase B leads to dephosphorylation of Forkhead box O3 increased atrophy; oxidative stress may stimulate upregulation of Stress-activated protein kinases (SAPK)/Jun amino-terminal kinases (JNK)/Forkhead box O3.	IIIC

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39	Lu K, Xu M, Li W, Wang K, Wang D. A study on dynamic monitoring, components, and risk factors of embolism during total knee arthroplasty. <i>Medicine (Baltimore)</i> . 2017;96(51):e9303.	Nonexperimental	40 TKA	n/a	n/a	transesophageal echocardiography (TEE) to diagnose embolism after tourniquet deflation, pulmonary arterial pressure (PAP), medullary cavity biopsies	Pulmonary arterial pressure peaks at 30 seconds after pneumatic tourniquet deflation, embolism had bone marrow particulates, quantity of embolus found correlated with increased age, Body mass index, & the fat content of bone marrow, which were also risk factors for pulmonary hypertension.	IIIB
40	Boutsidiadis A, Reynolds RJ, Saffarini M, Panisset JC. Factors that influence blood loss and need for transfusion following total knee arthroplasty. <i>Ann Transl Med</i> . 2017;5(21):418.	Nonexperimental	150 TKA	n/a	n/a	anticoagulation medication administration, type of anesthesia, TXA administration, presence of pneumatic tourniquet or drain, Hemoglobin preop & postop levels, blood transfusion requirement	preop Hemoglobin was associated with how much Hemoglobin decreased & whether TXA was used & both correlated with blood transfusion requirement.	IIIB
41	Benjamin JB, Colgan KM. Are routine blood salvage/preservation measures justified in all patients undergoing primary TKA and THA? <i>J Arthroplasty</i> . 2015;30(6):955-958.	Nonexperimental	366 TKA	n/a	n/a	transfusion requirements	Women were 6x more likely to require a blood transfusion, however this was not statistically significant; concluded that males might not need routine blood preservation techniques; choose selective adjuncts to blood salvage for females with low preop Hematocrit.	IIIB
42	Mori N, Kimura S, Onodera T, Iwasaki N, Nakagawa I, Masuda T. Use of a pneumatic tourniquet in total knee arthroplasty increases the risk of distal deep vein thrombosis: a prospective, randomized study. <i>Knee</i> . 2016;23(5):887-889.	RCT	103 pt	pneumatic tourniquet at 250 mmHg deflated after skin closure	pneumatic tourniquet - only during cementation	comorbidities. Operative time, total blood loss, & - distal, proximal, & total DVT	Distal & total DVT significantly higher with late release PT.	IA
43	Lai CK, Lee QJ, Wong YC, Wai YL. Incidence of deep vein thrombosis and its natural history following unilateral primary total knee replacement in local Chinese patients—a prospective study. <i>Journal of Orthopaedics, Trauma and Rehabilitation</i> . 2016;21:35-38.	Nonexperimental	390 TKA	n/a	n/a	DVT by Ultra Sound, distal & proximal incidence rate	Distal DVT higher incidence, comparable to Western countries, chemoprophylaxis might have influenced incidence rate but requires future studies.	IIIB
44	Watanabe H, Kikkawa I, Madoiwa S, Sekiya H, Hayasaka S, Sakata Y. Changes in blood coagulation–fibrinolysis markers by pneumatic tourniquet during total knee joint arthroplasty with venous thromboembolism. <i>J Arthroplasty</i> . 2014;29(3):569-573.	Nonexperimental	42 TKA	n/a	n/a	plasminogen activator inhibitor 1, synovial fluid mononuclear cell, D-dimer, leukocyte elastase immediately before & after pneumatic tourniquet release at 30, 90, & 180 seconds after stratifying to VTE or no VTE postop	plasminogen activator inhibitor 1 & D-dimer associated with asymptomatic VTE diagnosis; concluded to limit use of PT.	IIIB

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45	Zan P, Mol MO, Yao JJ, et al. Release of the tourniquet immediately after the implantation of the components reduces the incidence of deep vein thrombosis after primary total knee arthroplasty. <i>Bone Joint Res.</i> 2017;6(9):535-541.	Quasi-experimental	200 pt; 200 pt retrospective cohort	early release	prior cohort, tourniquet release after dressing	Transfusion at Hemoglobin <8 or symptomatic & <10, postop day 5-7 DVT by ultrasound (US), Gross formula to calculate total blood loss (TBL)	Found sign less DVT in early release, recommend early release practice.	IIB
46	Sun Y, Chen D, Xu Z, et al. Incidence of symptomatic and asymptomatic venous thromboembolism after elective knee arthroscopic surgery: a retrospective study with routinely applied venography. <i>Arthroscopy.</i> 2014;30(7):818-822.	Nonexperimental	537 pt	n/a	n/a	age, sex, BMI, operative time, pneumatic tourniquet time, surgery operator, type of procedure	Complex cases & older adults associated with higher incidence of VTE.	IIIB
47	Ye S, Dongyang C, Zhihong X, et al. The incidence of deep venous thrombosis after arthroscopically assisted anterior cruciate ligament reconstruction. <i>Arthroscopy.</i> 2013;29(4):742-747.	Nonexperimental	249 anterior cruciate ligament reconstruction pt; 24/171 DVT	n/a	n/a	DVT incidence	Older adults & female gender higher incidence; recommend routine prophylaxis for these procedures, but still no consensus.	IIIB
48	Guideline for prevention of venous thromboembolism. In: <i>Guidelines for Perioperative Practice.</i> Denver, CO: AORN, Inc; 2020:1101-1130.	Guideline	n/a	n/a	n/a	n/a	Guidance on additional ways to prevent VTEs.	IVA
49	Li Z, Liu D, Long G, et al. Association of tourniquet utilization with blood loss, rehabilitation, and complications in Chinese obese patients undergoing total knee arthroplasty: a retrospective study. <i>Medicine (Baltimore).</i> 2017;96(49):e9030.	Quasi-experimental	130 pt	PT	no PT	total EBL, intraoperative blood loss, hidden blood loss, transfusion volume, drain volume, difference between Hemoglobin preop & 5th postop day for thigh swelling rate, VAS, Knee Society Scale	Pneumatic tourniquet not related to decreased blood loss or increased postop complications in patients with higher body mass index.	IIC
50	Lozano LM, Tío M, Rios J, et al. Severe and morbid obesity (BMI ≥ 35 kg/m(2)) does not increase surgical time and length of hospital stay in total knee arthroplasty surgery. <i>Knee Surg Sports Traumatol Arthrosc.</i> 2015;23(6):1713-1719.	Nonexperimental	922 TKA	n/a	n/a	age, sex, weight, height, body mass index, ASA score, preop Hemoglobin at 2 months prior to surgery, hemostasis drug prescription, transfusions, length of hospital stay	Factors affecting length of stay including ASA score 3-4, preop Hemoglobin <13, preop diagnosis of anemia; not the patient's body mass index.	IIIB
51	Roth KE, Mandryka B, Maier GS, et al. In-vivo analysis of epicutaneous pressure distribution beneath a femoral tourniquet—an observational study. <i>BMC Musculoskelet Disord.</i> 2015;16:1.	Nonexperimental	25 consecutive pt	n/a	n/a	transfer of pressure to thigh skin, homogeneous distribution, variations over time, effect of limb circumference & body mass index on pressure distribution	Body mass index & associated higher circumference could affect deeper pressure points, surgical procedure may affect results; concluded that significant loss of pressure not related to patients' body mass index or circumference & to make overlap as narrow as possible.	IIIB

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52	Tuncali B, Boya H, Kayhan Z, Araç Ş. Obese patients require higher, but not high pneumatic tourniquet inflation pressures using a novel technique during total knee arthroplasty. Eklem Hastalik Cerrahisi. 2018;29(1):40-45.	Nonexperimental	208 TKA	n/a	n/a	intraoperative & postop systolic blood pressure, AOP, pressure, effectiveness, quality of field, circulation	The initial & maximum systolic blood pressure, arterial occlusion pressure (AOP), initial & maximum pressures were all higher in patients with high body mass index, but all good field visualization without complications.	IIIB
53	Tuncali B, Boya H, Kayhan Z, Araç Ş, Çamurdan MA. Clinical utilization of arterial occlusion pressure estimation method in lower limb surgery: effectiveness of tourniquet pressures. Acta Orthop Traumatol Turc. 2016;50(2):171-177.	Nonexperimental	198 operations, 224 Lower Extremities, 193 pt	n/a	n/a	pressure & effectiveness of Arterial Occlusion Pressure formula, quality of field & complications, time to set pressure	Time to measure AOP was 19 seconds, average AOP was 148.7 (initial pressure 168.4 maximum pressure 173.3); concluded AOP estimation formula is practical & efficient.	IIIB
54	Memtsoudis SG, Stundner O, Yoo D, et al. Does limb preconditioning reduce pain after total knee arthroplasty? A randomized, double-blind study. Clin Orthop Relat Res. 2014;472(5):1467-1474.	RCT	60 unilateral TKA	5 minute inflation & 5 minute reperfusion period	pneumatic tourniquet inflated only once	pain at rest & exercise, pain meds, systemic prothrombotic local inflammatory markers, LOS, pneumatic tourniquet milestones	Found significantly less pain at rest; no difference in medications, muscle oxidation, Interleukin 6, Tumor necrosis factor, prothrombolysis, length of stay, pneumatic tourniquet milestones; recommend more studies for mechanism, safety, & cost of pneumatic tourniquet use.	IA
55	Mittal R, Ko V, Adie S, et al. Tourniquet application only during cement fixation in total knee arthroplasty: a double-blind, randomized controlled trial. ANZ J Surg. 2012;82(6):428-433.	RCT	65 pt at 300 mmHg	pneumatic tourniquet during cement fixation	pneumatic tourniquet at incision to fixation	baseline Oxford Knee Score (OKS), range of motion, leg lag test, DVT screening within 2-6 weeks preop; transfusion & OKS, OKS at 26 & 52 week, ROM (measured photos) & lag (photos, difference between passive & active knee extension ranges) postop day 4, & week 2/10/26/52, stair test 2/10/26/52 week, knee pain postop day 4, analgesic consumption (paracetamol, pregabalin, or morphine equivalent dose), EBL (approx weight & hct changes, preop & postop 1), LOS, complications	Planned to r&omize 230 patients but discontinued study after 65 patients due to high transfusion rate in participants.	IA

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56	Saied A, Ayatollahi Mousavi A, Arabnejad F, Ahmadzadeh Heshmati A. Tourniquet in surgery of the limbs: a review of history, types and complications. Iran Red Crescent Med J. 2015;17(2):e9588.	Literature Review	n/a	n/a	n/a	n/a	Concludes there is not enough evidence to discontinue use of pneumatic tourniquet for extremity procedures.	VA
57	Parvizi J, Diaz-Ledezma C. Total knee replacement with the use of a tourniquet: more pros than cons. Bone Joint J. 2013;95-B(11 Suppl A):133-134.	Expert Opinion	n/a	n/a	n/a	n/a	Potential unequivocal population that cannot use pneumatic tourniquet known, currently recommend not using tourniquet with patients diagnosed with calcifications, PVD, vascular surgery, reconstruction or revision procedures; benefits may outweigh risk of using PT.	VB
58	Walls RJ, O'Malley J, O'Flanagan SJ, Kenny PJ, Leahy AL, Keogh P. Total knee replacement under tourniquet control: a prospective study of the peripheral arterial vasculature using colour-assisted duplex ultrasonography. Surgeon. 2015;13(6):303-307.	Nonexperimental	40 pt	n/a	n/a	prevalence & risk factors for PVD - smoking history, hypertension, diabetes, ischemic heart disease (IHD), hyper cholesterol, lower extremity (LE) claudication & rest pain, bilateral assessment of hair, skin, & nails, x-ray to see calcification	There was no significant change in blood flow; concluded that TKA with pneumatic tourniquet does not potentiate arterial injury with normal vasculature or mild PVD.	IIIB
59	Woelfle-Roos JV, Dautel L, Mayer B, Bieger R, Woelfle KD, Reichel H. Vascular calcifications on the preoperative radiograph: harbinger of tourniquet failure in patients undergoing total knee arthroplasty? Skeletal Radiol. 2017;46(9):1219-1224.	Quasi-experimental	765 pt screened, retrospectively compared groups	medial arterial calcification	no calcification	pneumatic tourniquet failure, intraoperative by cell-saving device, calcifications via x-ray	Found that vascular calcifications were not associated with pneumatic tourniquet failure, but recommended to be aware that minimizing cuff pressures may not be suitable with patients diagnosed with calcifications.	IIA
60	Koehler SM, Fields A, Noori N, Weiser M, Moucha CS, Bronson MJ. Safety of tourniquet use in total knee arthroplasty in patients with radiographic evidence of vascular calcifications. Am J Orthop (Belle Mead NJ). 2015;44(9):E308-E316.	Nonexperimental	373 TKA	n/a	n/a	calcifications versus none; predisposing factors	Male patients or patients with diagnosis of diabetes, hypertension, prior VTE, or coronary heart disease associated with increase complication separately; recommend taking a history & exam of risk factors diabetes, VTE, hypertension, coronary heart disease to look for PVD, vascular claudication or peripheral artery disease.	IIIB
61	Dermer R, Buckholz J. Surgical hemostasis by pneumatic ankle tourniquet during 3027 podiatric operations. J Foot Ankle Surg. 1995;34(3):236-246.	Nonexperimental	3027 podiatry cases	n/a	n/a	complication, pressure, time	3/5 complications were post-pneumatic tourniquet syndrome (7 total); conclude contraindications - poor circulation or vasculitis, hx DVT/pulmonary edema, sickle cell anemia, little ischemia as possible based on procedure.	IIIA

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62	Younger AS, McEwen JA, Inkpen K. Wide contoured thigh cuffs and automated limb occlusion measurement allow lower tourniquet pressures. Clin Orthop Relat Res. 2004;(428):286-293.	RCT	40 pt	wide cuff	standard cuff	SBP & quality of field (QOF)	Wide cuff significantly decrease limb occlusion pressure (LOP) & final cuff pressure, LOP technique has 80% accuracy; LOP & systolic blood pressure (SBP) weak linear correlation, so SBP should not be used to assume LOP.	IB
63	Jensen J, Hicks RW, Labovitz J. Understanding and optimizing tourniquet use during extremity surgery. AORN J. 2019;109(2):171-182.	Literature Review	n/a	n/a	n/a	n/a	Concludes to use waterproof drapes to prevent fluid accumulation under cuff & use lower inflation pressures when possible.	VA
64	Latex Allergy Management Guidelines. American Association of Nurse Anesthetists. www.aana.com/docs/default-source/practice-aana-com-web-documents-(all)/latex-allergy-management.pdf?sfvrsn=9c0049b1_8 . September 2018. Accessed March 5, 2020.	Guideline	n/a	n/a	n/a	n/a	Guidance to remove latex tourniquets if there is a latex allergy.	IVB
65	Guideline for a safe environment of care. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2020:115-150.	Guideline	n/a	n/a	n/a	n/a	Guidance for safe equipment use in the perioperative environment.	IVA
66	Thompson SM, Middleton M, Farook M, Cameron-Smith A, Bone S, Hassan A. The effect of sterile versus non-sterile tourniquets on microbiological colonisation in lower limb surgery. Ann R Coll Surg Engl. 2011;93(8):589-590.	Nonexperimental	70 reusable & single-use tourniquets	n/a	n/a	bacterial type & colony count	Methicillin-resistant Staphylococcus aureus (MRSA) was not isolated, but Staphylococcus found on 11/25 PT; sterile pneumatic tourniquet remained sterile.	IIIC
67	Din R, Geddes T. Skin protection beneath the tourniquet. A prospective randomized trial. ANZ J Surg. 2004;74(9):721-722.	RCT	150 pt	skin protection, soffban or drape	no protection	skin blisters	Found significantly less skin blisters with protection under the pneumatic tourniquet cuff.	IC
68	Olivecrona C, Tidermark J, Hamberg P, Ponzer S, Cederfjäll C. Skin protection underneath the pneumatic tourniquet during total knee arthroplasty: a randomized controlled trial of 92 patients. Acta Orthop. 2006;77(3):519-523.	RCT	92 pt	stockinette versus cast padding	no padding	blister incidence	Stockinette padding significantly better than no padding but not significant, but stockinette was better than cast padding, & cast padding was not significantly better than none; recommend using conical pneumatic tourniquet only pressure when following manufacturer's instruction for use (MIFU); concluded a lack of knowledge in safe pneumatic tourniquet application techniques & longer pneumatic tourniquet inflation time increase risk overall.	IB

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69	Kvederas G, Porvaneckas N, Andrijauskas A, et al. A randomized double-blind clinical trial of tourniquet application strategies for total knee arthroplasty. <i>Knee Surg Sports Traumatol Arthrosc.</i> 2013;21(12):2790-2799.	RCT	36 pt	pneumatic tourniquet - incision to harden versus cement to harden	pneumatic tourniquet - incision to skin	Hemoglobin & Hematocrit to calculate blood loss - classic, Gross, Sh&er's x Nadler's to calculate, body surface area, plus red blood cell volume for each method to calculate EBL, Timed Up & Go postop day 2, fit to discharge = pain with NSAID, Timed Up & Go <20 s, wound healing, body temperature <37.7	Pneumatic tourniquet inflation from incision to cement hardening & cement-only increased EBL; functional Timed Up & Go recovery was better in incision to cement group, time to be fit to discharge shorter with shorter pneumatic tourniquet inflation time.	IB
70	Zhang Y, Li D, Liu P, Wang X, Li M. Effects of different methods of using pneumatic tourniquet in patients undergoing total knee arthroplasty: a randomized control trial. <i>Irish J Med Sci.</i> 2017;186(4):953-959.	RCT	150 pt	pneumatic tourniquet - entire incision to dressing versus beginning incision to joint replacement before skin closure	pneumatic tourniquet - osteotomy to dressing	intraoperative blood loss (IBL), postop blood loss (PBL), hidden blood loss (HBL), total blood loss (TBL), operative time, pneumatic tourniquet time, complications, Hospital for Special Surgery score	Less pneumatic tourniquet inflation time associated with less complications; more pneumatic tourniquet time increases redness, swelling, DVT, convenience, accuracy, & EBL; recommend limiting the role of PT, exercise caution with use.	IA
71	Yakumpor T, Panichkul P, Kanitnate S, Tammachote N. Blood loss in TKA with tourniquet release before and after wound closure. <i>J Med Assoc Thai.</i> 2018;101(10):1443-1449.	RCT	64 TKA	pneumatic tourniquet - released before polyethylene implant inserted	pneumatic tourniquet - released after wound closure	measured EBL, blood drainage, 24 hour drop Hematocrit, change in Hematocrit, transfusion rate, wound complications, DVT, knee flexion; 3 month follow up	Total blood loss was no different because higher intraoperative blood loss associated with less postop drainage; early release had lower transfusion rate & no difference in complications or postop knee flexion.	IA
72	Olivecrona C, Ponzer S, Hamberg P, Blomfeldt R. Lower tourniquet cuff pressure reduces postoperative wound complications after total knee arthroplasty: a randomized controlled study of 164 patients. <i>J Bone Joint Surg Am.</i> 2012;94(24):2216-2221.	RCT	164 pt	LOP	surgeon decides pressure	pain, quality of field, range of motion, complications at discharge & 2 month	LOP lowers pressure but no difference pain, visual analog scale & field visualization, complications, or range of motion, but associated with less stiffness; both pressure parameters have good postop outcomes.	IA
73	Na YG, Bamne AB, Won HH, Kim TK. After early release of tourniquet in total knee arthroplasty, should it be reinflated or kept deflated? A randomized trial. <i>Knee Surg Sports Traumatol Arthrosc.</i> 2017;25(9):2769-2777.	RCT	210 TKA	early release	re-inflation of PT after early release	field visibility, operative time, drainage, Hemoglobin postop day 2 & 5, transfusion, knee & thigh pain visual analog scale, wound complications, pneumatic tourniquet site complications, major complications	No difference in operative time, postop blood loss, Hemoglobin, transfusion, pain, or complications; concluded that re-inflation after early release may be safe alternative for better field visibility.	IA

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74	Martín BC, Martín JIC, Oliver JL, Gómez JD. The effect of hyperoxygenated fatty acids in preventing skin lesions caused by surgical pneumatic tourniquets. <i>Adv Skin Wound Care</i> . 2018;31(5):214-217.	Quasi-experimental	174 pt	hyper oxygenated fatty acids & elastic wrap under pneumatic tourniquet cuff	b&age	demographics & grade of skin lesions	Age, body mass index, PT pressure, & inflation time were not correlated with lesion; recommend to prevent skin friction any way possible.	IIIB
75	Bosman HA, Robinson AH. Pneumatic tourniquet use in foot and ankle surgery—is padding necessary? <i>Foot (Edinb)</i> . 2014;24(2):72-74.	Nonexperimental	97 pt (47 thigh, 50 ankle)	n/a	n/a	procedure, pneumatic tourniquet time, body mass index, comorbidities, ASA score, location, preop conditions, skin postop & 1 hour & 2 week	3 neuropathy injuries, recommend omitting pneumatic tourniquet use with caution.	IIIB
76	Tredwell SJ, Wilmink M, Inkpen K, McEwen JA. Pediatric tourniquets: analysis of cuff and limb interface, current practice, and guidelines for use. <i>J Pediatr Orthop</i> . 2001;21(5):671-676.	Nonexperimental	2 healthy children, 4 total limbs	n/a	n/a	maximum height & sum of wrinkles	Of 4 pneumatic tourniquet br&s, one had specific sleeve padding & had significantly lower maximum height & sums of wrinkles with stretch for overlap than 2 other pneumatic tourniquet br&s with cast padding & 1 pneumatic tourniquet without padding; recommendations for pediatrics - most proximal area, widest cuff, manufacturer-specific sleeve or 2 layers of stockinette, snug fit, LOP+ 50 safety margin, exsanguinate based on pneumatic tourniquet & procedure, monitor during inflation, 25 mmHg increments, minimum time, remove after deflation.	IIIC
77	The Joint Commission. Sentinel event alert: Managing risk during transition to new ISO tubing connector standards. <i>Sentinel Event Alert</i> . 2014(53):1-6.	Regulatory	n/a	n/a	n/a	n/a	Strategies to preventing tubing misconnections (eg, effective processes, procedures, & communication & appropriate education, training, & safety culture)	n/a
78	Akinyoola AL, Adegbehingbe OO, Odunsi A. Timing of antibiotic prophylaxis in tourniquet surgery. <i>J Foot Ankle Surg</i> . 2011;50(4):374-376.	RCT	106 pt all ages	antibiotics 5 minutes before exsanguination & inflation	antibiotics 1 minute after inflation	rate of infection, healing time, surgeon satisfaction with healing	Administering antibiotics after inflation had significantly less infections & healing time & increase surgeon satisfaction with healing.	IB

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79	Soriano A, Bori G, García-Ramiro S, et al. Timing of antibiotic prophylaxis for primary total knee arthroplasty performed during ischemia. Clin Infect Dis. 2008;46(7):1009-1014.	RCT	908 pt	antibiotics 10-30 minutes before incision	10 before deflation	3,12 month of surgical site infection (SSI)	There were no significant difference, but require more studies to prove one is better, however administering antibiotics before pneumatic tourniquet deflation is not inferior to before incision.	IB
80	Prats L, Valls J, Ros J, Jover A, Pérez-Villar F, Fernández-Martínez JJ. Influence of the ischaemic tourniquet in antibiotic prophylaxis in total knee replacement. Rev Esp Cir Ortop Traumatol. 2015;59(4):275-280.	Nonexperimental	32 pt	n/a	n/a	observed antibiotic concentration before & after pneumatic tourniquet use	Antibiotic concentration gradually decreases during operation, but remained over minimum inhibitory concentration level.	IIIB
81	Dounis E, Tsourvakas S, Kalivas L, Giamaçellou H. Effect of time interval on tissue concentrations of cephalosporins after tourniquet inflation. Highest levels achieved by administration 20 minutes before inflation. Acta Orthop Scand. 1995;66(2):158-160.	Quasi-experimental	62 pt	ceftazidime	ceftriaxone or ceforanide	tissue from skin, fat, muscle, bone at 20 minutes, 2 hour & 4 hour	Maximum antibiotic tissue concentration in soft tissue & bone at 20 minutes.	IIB
82	Papaioannou N, Kalivas L, Kalavritinos J, Tsourvakas S. Tissue concentrations of third-generation cephalosporins (ceftazidime and ceftriaxone) in lower extremity tissues using a tourniquet. Arch Orthop Trauma Surg. 1994;113(3):167-169.	Nonexperimental	47 pt	n/a	n/a	tissue & bone concentration of ceftazidime & ceftriaxone antibiotics at 10 minutes, 20 minutes, 2 hour, 4 hour before inflation	Highest concentration at 20 minutes, 4 hour lowest concentration for both, ceftriaxone highest at 10 minutes; administering antibiotics the night before no longer recommended.	IIIB
83	Bicanic G, Crnogaca K, Barbaric K, Delimar D. Cefazolin should be administered maximum 30 min before incision in total knee arthroplasty when tourniquet is used. Med Hypotheses. 2014;82(6):766-768.	Literature Review	n/a	n/a	n/a	n/a	Administering antibiotics 30 minutes before incision or tourniquet inflation or at least 10 minutes before inflation seem to be efficient to achieve optimal tissue concentration.	VB
84	Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm. 2013;70(3):195-283.	Guideline	n/a	n/a	n/a	n/a	10-30 minutes before versus 10 minutes before deflation found no significant difference; selection based on cost, availability, local resistance patterns; premixed antibiotic cement is FDA approved in revision.	IVA
85	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;22(2):126-130.	RCT	64 pt	SBP+100 PT pressure for entire surgery	no PT	knee extension strength; secondary pain, nausea, length of stay, periarticular swelling	No difference in strength but not using pneumatic tourniquet may increase efferent activation.	IA

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86	Reda W, ElGuindy AM, Zahry G, Faggal MS, Karim MA. Anterior cruciate ligament reconstruction; is a tourniquet necessary? A randomized controlled trial. <i>Knee Surg Sports Traumatol Arthrosc.</i> 2016;24(9):2948-2952.	RCT	58 pt Anterior cruciate ligament reconstruction	pneumatic tourniquet 350 mmHg	no pneumatic tourniquet, received intra-articular injection	1 week girth & strength of quadriceps & hamstring at 60 & 180 seconds	No difference in field visibility, operative time, or muscle power preop & 6 month; pain & analgesic need was higher 4, 10 hour, drain EBL higher, strength improvement was limited to immediate postop phase without pneumatic tourniquet use.	IA
87	Wu Y, Lu X, Ma Y, et al. Efficacy and safety of limb position on blood loss and range of motion after total knee arthroplasty without tourniquet: a randomized clinical trial. <i>Int J Surg.</i> 2018;60:182-187.	RCT	100 TKA	knee at 60 degrees for 24 hour postop, no PT	pneumatic tourniquet at 250 mmHg & flexion	Hgb & Hct & platelet preop numbers, total, intraop, & hidden blood loss, drain volume, transfusion rate, maximum Hgb drop, circumference, visual analog scale, ROM, LOS, DVT, pulmonary edema, complications; Gross calculaiton for blood loss, complications at discharge, 1, & 6 months.	Pneumatic tourniquet use decrease range of motion through 1 month postop; no pneumatic tourniquet decrease intraoperative blood loss, hidden blood loss, drainage volume, visual analog scale & circumference through postop day 5; but no difference in total blood loss, Hemoglobin difference, transfusion rate, length of stay, DVT, complications, or range of motion after 6 months.	IA
88	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. <i>Int Orthop.</i> 2014;38(2):355-359.	RCT	64 pt	pneumatic tourniquet - osteotomy to leg wrap with elastic b&age	pneumatic tourniquet - incision to b&age	operative time, EBL, visual analog scale score, swelling index, 90 degree flexion of knee, DVT	By day 7, no significant differences, though there were significant differences with early release for pneumatic tourniquet inflation time, postop blood loss, calculated blood loss, & visual analog scale postop day 1,3; swelling postop day 3; & days to 90 degree flexion of knee.	IA
89	Chiu FY, Hung SH, Chuang TY, Chiang SC. The impact of exsanguination by Esmarch bandage on venous hemodynamic changes in total knee arthroplasty—a prospective randomized study of 38 knees. <i>Knee.</i> 2012;19(3):213-217.	RCT	38 pt male	Esmarch	no Esmarch	strain-gage plethysmography preoply, postop day 2,6,14,28, every 6 month venous outflow - volume of blood between .5 - 2 seconds after release of cuff	Greater trend to venous outflow & capacitance with Esmarch, arterial filling index decreased; both return to baseline by postop day 14; concluded that there were no adverse events from using Esmarch, but that it may not be necessary.	IB
90	Fan Y, Jin J, Sun Z, et al. The limited use of a tourniquet during total knee arthroplasty: a randomized controlled trial. <i>Knee.</i> 2014;21(6):1263-1268.	RCT	60 pt	pneumatic tourniquet - entire procedure	pneumatic tourniquet - cementation to end	operative time, pneumatic tourniquet time, EBL, complications, Hemoglobin concentration, swelling & pain, range of motion	Longer pneumatic tourniquet inflation time associated with more complications; recommend less use of pneumatic tourniquet related to decrease in swelling, pain, & no difference in operative time, EBL or functional recovery.	IA

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91	Chang CW, Lan SM, Tai TW, Lai KA, Yang CY. An effective method to reduce ischemia time during total knee arthroplasty. <i>J Formos Med Assoc.</i> 2012;111(1):19-23.	Quasi-experimental	72 pt	pneumatic tourniquet - release after tight arthrotomy closure	released before skin closure	operative time, pneumatic tourniquet time, Hemoglobin decrease, transfusion, range of motion, Oxford Knee Score (OKS)	Early release had better range of motion at 6 week, no difference otherwise; continue discussion on intraoperative pneumatic tourniquet inflation time.	IIB
92	Ledin H, Aspenberg P, Good L. Tourniquet use in total knee replacement does not improve fixation, but appears to reduce final range of motion. <i>Acta Orthopaedica.</i> 2012;83(5):499-503.	RCT	50 pt	no PT	PT	Radio stereographic analysis (RSA) migration postop, 6 month, 1 year, 2 year, visual analog scale & morphine consumption, overt blood loss & transfusion, total blood loss measured by Hgb dilution, range of motion at 2 year	Pneumatic tourniquet increased pain & decreased range of motion, no difference in 1 year implant fixation.	IA
93	Dennis DA, Kittelson AJ, Yang CC, Miner TM, Kim RH, Stevens-Lapsley J. Does tourniquet use in TKA affect recovery of lower extremity strength and function? A randomized trial. <i>Clin Orthop Relat Res.</i> 2016;474(1):69-77.	RCT	28 pt same-day bilateral TKA	pneumatic tourniquet - before incision to after cementation	short PT inflation time or no PT	voluntary quadricep activation, hamstring strength, unilateral limb balance, operative time, EBL at assess preop, 3 week, 3 month	Pneumatic tourniquet decrease quadricep strength at 3 month; unclear long-term & functional outcomes.	IB
94	Tarwala R, Dorr LD, Gilbert PK, Wan Z, Long WT. Tourniquet use during cementation only during total knee arthroplasty: a randomized trial. <i>Clin Orthop Relat Res.</i> 2014;472(1):169-174.	RCT	71 pt	incision to cement	cement	pain by visual analog scale every 6 hours for 24 hour with mean recorded, quadricep function postop day 2 & 3 on a scale 0-5, range of motion extension & flexion postop day 1,2,3, & 3/6 week, minor complications - manipulation under anesthesia, major complication - revisions, changed outcome, threatening; pain, milligrams of morphine, knee flexion, Hgb, EBL, drain output, total EBL, op time	Pain was no different, intraoperative blood loss was significantly lower with longer PT time, total blood loss not significant; pilot of 40 pt showed power analysis of 260 pt required, disb&ed for equivalence was proven.	IA
95	Angadi DS, Blanco J, Garde A, West SC. Lower limb elevation: Useful and effective technique of exsanguination prior to knee arthroscopy. <i>Knee Surg Sports Traumatol Arthrosc.</i> 2010;18(11):1559-1561. doi: 10.1007/s00167-010-1165-6.	Nonexperimental	50 pt	n/a	n/a	pneumatic tourniquet time, time to incision, complications	No difference in pneumatic tourniquet time or complications, risk associated with Rhys-Davies exsanguination technique; recommend only elevate to exsanguinate extremity.	IIIC

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96	Vertullo CJ, Nagarajan M. Is cement penetration in TKR reduced by not using a tourniquet during cementation? A single blinded, randomized trial. J Orthop Surg (Hong Kong). 2017;25(1):2309499016684323.	RCT	40 pt	pneumatic tourniquet - during cement only	no PT	mean 3 column penetration values of plateau & central penetration, tibial baseplate size, thickness, & stem diameter	Procedural methods to clear field are as effective as using pneumatic tourniquet during cementation.	IA
97	Vaishya R, Agarwal AK, Vijay V, Tiwari MK. Short term outcomes of long duration versus short duration tourniquet in primary total knee arthroplasty: a randomized controlled trial. J Clin Orthop Trauma. 2018;9(1):46-50.	RCT	80 knees	pneumatic tourniquet - inflation to cement	pneumatic tourniquet - incision to cement	intraop blood loss by suction canisters & laps, postop blood loss by drain volume, postop day 1 Hemoglobin x-ray, transfusion at <8, drain removed postop day 2 with physical therapy, Knee Society Scale, range of motion & visual analog scale by follow up every 1 2 6 weeks	No DVT in either group, 11 late release knees presented with swelling & redness; need to validate that shorter operative time with pneumatic tourniquet use is worth a potential increase complications, reactionary increase in EBL after pneumatic tourniquet release may not be as beneficial.	IA
98	Zhang M, Liu G, Zhao Z, Wu P, Liu W. Comparison of lower limb lifting and squeeze exsanguination before tourniquet inflation during total knee arthroplasty. BMC Musculoskelet Disord. 2019;20(1):35.	RCT	236 pt	h& over h& squeezing with elastic rubber squeeze	lifting method	primary visual analog scale, complications, secondary pneumatic tourniquet time, operative time, intraoperative blood loss (suction & gauze), drain, calculated by Gross formula, knee function (measured by average of 3 goniometer measurements), Hospital for Special Surgery & visual analog scale of pain	No difference in pneumatic tourniquet inflation time, operative time, intraoperative blood loss, drain, or calculated blood loss; h& over h& had significantly higher pain postop day 1 & 7 significant difference, blisters & total complications; concluded - lifting for exsanguination is safe to decrease risk of skin blisters & pain.	IB
99	Barron SL, McGrory BJ. Total knee arthroplasty in a patient with ipsilateral calcific myonecrosis. Arthroplast Today. 2018;4(4):421-425.	Case Report	n/a	n/a	n/a	n/a	Limiting tourniquet use to cement-only time & not exsanguinating allowed for tourniquet use by not rupturing calcific myonecrosis mass.	VA
100	Tanpowpong T, Kitidumrongsook P, Patradul A. The deleterious effects of exsanguination with a tight bandage on tourniquet tolerance in the upper arm. J Hand Surg Eur Vol. 2012;37(9):839-841.	Quasi-experimental	23 healthy	elevation	elastic b&	age, sex, height, weight, BP, arm length, arm circumference, visual analog scale 1-10	Found that elevation exsanguination promotes pain tolerance; recommend elevating if not using general anesthesia.	IIC
101	Huang GS, Wang CC, Hu MH, et al. Bilateral passive leg raising attenuates and delays tourniquet deflation-induced hypotension and tachycardia under spinal anaesthesia: a randomised controlled trial. Eur J Anaesthesiol. 2014;31(1):15-22.	RCT	70 pt	passive leg raising (PLR) during deflation	supine entire time	BP & heart rate (HR) before during after PT, BP nadir	Bilateral passive leg raise is simple, reversible, & attenuates physiologic reaction from pneumatic tourniquet deflation; concluded to use elastic wrap.	IA

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102	Haghighi M, Mardani-Kivi M, Mirbolook A, et al. A comparison between single and double tourniquet technique in distal upper limb orthopedic surgeries with intravenous regional anesthesia. <i>Arch Bone Jt Surg.</i> 2018;6(1):63-70.	RCT	80 pt UE IVRA lidocaine	single wide PT	double narrow PT	Visual analog scale, onset & maximum pain, fentanyl consumption	Wide pneumatic tourniquet cuff associated with less pain but similar fentanyl consumption under 40 minutes; conclude that single pneumatic tourniquet cuff has less potential toxicity related to switching pneumatic tourniquet cuffs & releasing medication.	IA
103	Tuncali B., Boya H., Kayhan Z., Arac S. Tourniquet pressure settings based on limb occlusion pressure determination or arterial occlusion pressure estimation in total knee arthroplasty? A prospective, randomized, double blind trial. <i>Acta Orthop Traumatol Turc.</i> 2018;52(4):256-260.	RCT	93 pt	LOP	arterial occlusion pressure estimation	initial & maximum SBP, LOP/AOP levels, time to estimate & set pressure, initial & maximum pneumatic tourniquet pressure, pneumatic tourniquet time, effectiveness	AOP estimate comparable to LOP measurement, but found lower pressure & took less time to measure.	IB
104	Sáenz-Jalón M, Ballesteros-Sanz M, Sarabia-Cobo C, et al. Assessment of the pneumatic ischemia technique using the limb occlusion pressure during upper limb surgery. <i>J Perianesth Nurs.</i> 2018;33(5):699-707.	RCT	160 pt	LOP	standard 300 mmHg	field visibility on a 4 Likert scale, & team opinion of quality on a 0-9, hyperemia 1-5 after & postop (body cleaning metabolic waste anoxia), pain 1-10 postop & 24 hour postop	LOP required less general anesthetic conversions due to unbearable pain; conclude that LOP safe parameter that decreased pain & hyperemia in the control group.	IB
105	Mu J., Liu D., Ji D., et al. Determination of pneumatic tourniquet pressure of lower limb by ultrasonic doppler. <i>Ann Plast Surg.</i> 2018;80(3):290-292.	RCT	96 pt	Doppler for maximum systolic velocity	pneumatic tourniquet by surgeon preference	pneumatic tourniquet pressure, hemostatic effect, incidence of adverse reaction	Doppler method found significantly lower pressure, with no difference in pneumatic tourniquet inflation time or field visibility with significantly less complications.	IA
106	Ding L, Ding CY, Wang YL, et al. Application effect of pneumatic tourniquet with individualized pressure setting in orthopedic surgery of extremities: a meta-analysis. <i>J Adv Nurs.</i> 2019;75(12):3424-3433	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	2003- 2016 9 Chinese RCTs included with 1200 patients; lower pressure improves hemostatic effect & reduces complications, no difference in operative time.	IB
107	Lim E, Shukla L, Barker A, Trotter DJ. Randomized blinded control trial into tourniquet tolerance in awake volunteers. <i>ANZ J Surg.</i> 2015;85(9):636-638.	RCT	40 healthy volunteers	200 mmHg	250 mmHg	Vital signs & pain, grip strength until return to normal	Found less pain with lower pressure; 200 mmHg better tolerated during procedures not under general anesthesia, but still need to assess upper limit.	IB
108	Masri BA, Day B, Younger ASE, Jeyasurya J. Technique for measuring limb occlusion pressure that facilitates personalized tourniquet systems: A randomized trial. <i>Journal of medical and biological engineering.</i> 2016;36(5):644-650.	RCT	143 pt, 252 total measurements	automatic LOP	doppler LOP	pressure measurement	There was no difference in pressure with new machine or Doppler; safe to use proposed method with machine.	IB

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109	Liu HY, Guo JY, Zhang ZB, Li KY, Wang WD. Development of adaptive pneumatic tourniquet systems based on minimal inflation pressure for upper limb surgeries. <i>Biomed Eng Online</i> . 2013;12:92.	Nonexperimental	70 healthy soldiers	n/a	n/a	BMI, Blood Flow velocity & Blood Pressure (BP), occlusion diagnosed by plethysmograph, proposed AOP formula & machine-measured limb occlusion pressure compared	There was no difference in quality of field (QOF) visualization or complications between groups, but pressure was significantly different at each time point; conclude to continue modifying AOP formula.	IIIB
110	Sato J, Ishii Y, Noguchi H, Takeda M. Safety and efficacy of a new tourniquet system. <i>BMC Surg</i> . 2012;12:17	Nonexperimental	120 consecutive upper extremity procedures	n/a	n/a	field visibility & complications	Pressure by vital information monitor machine system synchronized with SBP but did not significantly lower pressures; conclude recommend PT pressure for SBP+100 for upper extremity (UE) procedures.	IIIB
111	Anderson JG, Bohay DR, Maskill JD, et al. Complications after popliteal block for foot and ankle surgery. <i>Foot Ankle Int</i> . 2015;36(10):1138-1143.	Nonexperimental	1014 pt foot/ankle	n/a	n/a	pneumatic tourniquet time, pressure, location analyzed separately for neuropathic complications	No significant results, pneumatic tourniquet not likely to change clinically meaningful to outcomes.	IIIB
112	Sarfani S, Cantwell S, Shin AY, Kakar S. Challenging the dogma of tourniquet pressure requirements for upper extremity surgery. <i>J Wrist Surg</i> . 2016;5(2):120-123.	Quasi-experimental	432 pt	125 v 150 v 175 v 200 mmHg based on SBP	250 mmHg	operative or anesthesia time, complications, adjustments to higher pressures	No difference in operative or anesthesia time as well as no complications or pressure adjustments; conclude to reduce pressures during carpal tunnel release is acceptable.	IIC
113	Lieberman JR, Staheli LT, Dales MC. Tourniquet pressures on pediatric patients: A clinical study. <i>Orthopedics</i> . 1997;20(12):1143-1147.	Nonexperimental	29 pediatrics	n/a	n/a	pneumatic tourniquet time, high & low operative BP, inadequate field, increase pressure needed, failure & SBP at that time	Lower extremity occlusion was 95% adequate for field visibility 100 mmHg above LOP, upper extremity was 100% adequate at 75 mmHg above LOP; lower pressures generally acceptable; 34% of procedures required a pressure higher than twice the patient's SBP.	IIIB
114	Unver B., Karatosun V., Tuncali B. Effects of tourniquet pressure on rehabilitation outcomes in patients undergoing total knee arthroplasty. <i>Orthop Nurs</i> . 2013;32(4):217-222.	Quasi-experimental	38 pt	AOP estimation formula & maximum SBP <100 & MAP >60 (= controlled hypotension)	conventional pressure 300 mmHg	visible analog scale pain, Iowa level of assistance scale (ILAS), ambulation velocity scale, straight leg & 70 degree flexion, hospital for special surgery knee score (HSS) & range of motion at 6, 12, 26 week, ILAS postop day 2 & 6, pain at discharge	Researchers found decreased pain & quicker recovery of knee flexion related to lower pressures.	IIB
115	McEwen JA, Kelly DL, Jordanowski T, Inkpen K. Tourniquet safety in lower leg applications. <i>Orthop Nurs</i> . 2002;21(5):55-62.	RCT	16 volunteers; 53 reviewed cases	automatic LOP	doppler LOP	pressure difference between Doppler & automatic machine LOP	There was a significant difference between Doppler & auto pressures, significantly lower mean pressure for wide, contoured cuff, though automatic pressures might not be as precise.	IC

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116	Olivecrona C, Blomfeldt R, Ponzer S, Stanford BR, Nilsson BY. Tourniquet cuff pressure and nerve injury in knee arthroplasty in a bloodless field: a neurophysiological study. <i>Acta Orthop</i> . 2013;84(2):159-164.	RCT	40 pt	AOP formula + safety margin	350 mmHg	Oxygen levels of both legs & field visibility	AOP + safety margin was ineffective & researchers stopped the study early due to poor field visibility.	IB
117	Perez BA, Smith BA, Gugala Z, Lindsey R. The reduced cuff inflation protocol does not improve the tissue oxygen recovery after tourniquet ischemia. <i>J Anesth Clin Res</i> . 2014;5:474.	Quasi-experimental	18 pt	LOP	MD decides pressure based on SBP	electroneurography ENeG & quantitative sensory testing QST of thermal thresholds on postop day 3 & 2 months with electromyography EMG - follow up at 18 month for symptomatic nerve injury	2% incident rate of complications, concluded that 240 mm Hg for 80 minutes was safe regarding the risk for nerve injury.	IIB
118	Graham B, Breault MJ, McEwen JA, McGraw RW. Occlusion of arterial flow in the extremities at subsystolic pressures through the use of wide tourniquet cuffs. <i>Clin Orthop Relat Res</i> . 1993;(286):257-261.	RCT	26 volunteers, 60 patients	curved, wide cuff with LOP machine measurement; patients - observed LOP+50 mmHg safety margin	cylindrical, narrow cuff with LOP Doppler pressure measurement	pressure & field visibility	LOP had significantly lower pressure; 5/10 had fair/poor field visibility associated with an increase in SBP; concluded that curved & wider cuffs minimize pressure & decrease the risk of neuromuscular injury.	IB
119	Graham B, Breault MJ, McEwen JA, McGraw RW. Occlusion of arterial flow in the extremities at subsystolic pressures through the use of wide tourniquet cuffs. <i>CLIN ORTHOP RELATED RES</i> . 1993;286:257-261.	Quasi-experimental	34 healthy volunteers	tourniquet width	smallest width	ultrasonic flowmetry LOP; thigh circumference	Lowest pressure was associated with a width to circumference 0.3 : 1 ratio; use widest tourniquet for lower inflation pressure.	IIC
120	Kokki H, Väättäin U, Penttilä I. Metabolic effects of a low-pressure tourniquet system compared with a high-pressure tourniquet system in arthroscopic anterior crucial ligament reconstruction. <i>Acta Anaesthesiol Scand</i> . 1998;42(4):418-424.	RCT	26 pt	low pressure, wide curved cuff with microprocessor	st&ard narrow straight with higher pressure	injury & metabolism	Pneumatic tourniquet deflation significantly released lactate, myoglobin, potassium, & increased carbon dioxide; more metabolic changes with longer pneumatic tourniquet time, no difference at 60 minutes after deflation.	IC
121	Tie K, Hu D, Qi Y, Wang H, Chen L. Effects of tourniquet release on total knee arthroplasty. <i>Orthopedics</i> . 2016;39(4):e642-e650.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	1966-2015, 16 RCTs included, 1073 patients; researchers found similar results but early release of PT had less complications (eg, calculated blood loss, Hemoglobin/Hematocrit drop, postop blood loss, total blood loss, transfusion rate, operative time, DVT incidence).	IB

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122	Zan PF, Yang Y, Fu D, Yu X, Li GD. Releasing of tourniquet before wound closure or not in total knee arthroplasty: a meta-analysis of randomized controlled trials. <i>J Arthroplasty</i> . 2015;30(1):31-37.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	1979 - 2014 16 RCTs included; researchers concluded that minor complications (eg, erythema, marginal necrosis, cellulitis, superficial infection, oozing, significant swelling, DVT) were more common in the pneumatic tourniquet group; need consistent reporting in more RCT.	IA
123	Wang C, Zhou C, Qu H, Yan S, Pan Z. Comparison of tourniquet application only during cementation and long-duration tourniquet application in total knee arthroplasty: a meta-analysis. <i>J Orthop Surg Res</i> . 2018;13(1):216.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	1997-2016 7 RCTs included, 440 TKAs; early release of PT allows hemostasis, increased bleeding related to fibrinolytic activity; relevant EBL considering preop Hemoglobin & body mass index; variability in transfusion requirements lead to nonsignificant result; pneumatic tourniquet during cementation does not affect postop rehabilitation, limb swelling, quadricep strength; 1 compartment syndrome with pneumatic tourniquet use, wound complications related to the oxygen supply to soft tissues, inflammation, muscle damage; researchers concluded that the results were insufficient, varied, & too short & required follow up to make recommendations.	IB
124	Huang Z, Ma J, Zhu Y, et al. Timing of tourniquet release in total knee arthroplasty. <i>Orthopedics</i> . 2015;38(7):445-451.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	1979-2012 14 RCTs included, TKAs; pneumatic tourniquet significantly decreased measured blood loss, but there's no difference for DVT, infection, or minor & major complications; studies had limited randomization, missing data, heterogeneity of populations; researchers concluded with proper control of pressure & inflation time, late release does not increase complications.	IA

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125	Rathod P, Deshmukh A, Robinson J, Greiz M, Ranawat A, Rodriguez J. Does tourniquet time in primary total knee arthroplasty influence clinical recovery?. <i>J Knee Surg</i> . 2015;28(4):335-342.	Quasi-experimental	73 pt	pneumatic tourniquet cementation-only	pneumatic tourniquet - incision to arthrotomy closure	Knee Society Scale, ROM, flexion contracture, extensor lag, quadricep strength, visual analog scale, circumference of knee at 6 week, 3 month, & 1 year, Short Form 36 regarding physical & mental component scores, operative & pneumatic tourniquet time, Hemoglobin & Hematocrit postop day 1,2,3; visual analog scale for pain on postop 4, 24,48,72 hour; postop passive & active straight leg raise (SLR) 24,48,72 hour; length of stay at 72 hour, narcotic use at hours 24, 48,72 & average dose; xray at 6 week postop	Pneumatic tourniquet inflated only during cementation had no negative effects on cement efficacy.	IIC
126	Wang K, Ni S, Li Z, et al. The effects of tourniquet use in total knee arthroplasty: a randomized, controlled trial. <i>Knee Surg Sports Traumatol Arthrosc</i> . 2017;25(9):2849-2857.	RCT	50 pt	pneumatic tourniquet - incision to harden cement	pneumatic tourniquet - cement to harden cement	Hgb/Hct at preop, & postop day 1,2,5; calculated, intraop, postop, & hidden blood loss, Gross formula for postop blood loss; visual analog scale for thigh & knee pain, circum thigh, knee, calf; pulmonary embolism or DVT incidence; operative time, transfusion, clinical outcome Western Ontario & McMaster Universities Arthritis Index (WOMAC), straight leg raising, ROM	Longer pneumatic tourniquet inflation time decreased total & intraoperative blood loss; shorter pneumatic tourniquet inflation time decreased postop & hidden blood loss, no increase in transfusion rate, faster recovery, & less pain with early stages of rehabilitation with shorter PT time.	IA

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127	Huang ZY, Pei FX, Ma J, et al. Comparison of three different tourniquet application strategies for minimally invasive total knee arthroplasty: a prospective non-randomized clinical trial. Arch Orthop Trauma Surg. 2014;134(4):561-570.	Quasi-experimental	90 pt	pneumatic tourniquet time before incision & after cement, before prosthesis & after cement	pneumatic tourniquet - entire time (incision to closure)	ROM, straight leg, preop hospital for special surgery (HSS) knee score, girth/swelling by circumference, operative time, pneumatic tourniquet time, EBL, length of stay, drain volume, transfusion requirement, Hgb & Hct preop, postop, postop day (POD) 1,2,3; EBL by Gross formula; CRP & interleukin-6 for inflammation & surgical insult; creatine kinase & myoglobin (muscle damage) at same points	Found more soft tissue injury, but muscle damage markers did not reflect injury; no difference swelling, pain, length of stay; increase of pneumatic tourniquet time associated with increased inflammation & decreased EBL; concluded that pneumatic tourniquet <225 mm Hg & <120 minutes might not reflect significant negative impact in functional assessments.	IIB
128	Abbas K, Raza H, Umer M, Hafeez K. Effect of early release of tourniquet in total knee arthroplasty. J Coll Physicians Surg Pak. 2013;23(8):562-565.	Quasi-experimental	130 pt	early release	release after dressing	EBL, transfusion, operative time	Early release had no effect on blood conservation, but increased operative time, transfusion rate, & length of stay; late release associated with higher complication incidence (potentially related to comorbidities) but effective.	IIC
129	Wakai A, Wang JH, Winter DC, Street JT, O'Sullivan RG, Redmond HP. Tourniquet-induced systemic inflammatory response in extremity surgery. J Trauma. 2001;51(5):922-926.	RCT	26 patients	tourniquet-assisted procedures	no tourniquet	systemic proinflammatory response before, after 15 minutes, 4 hours, 24 hours of reperfusion after deflation	After 15 minutes, polymorphonuclear neutrophil CD11b significantly increased, monocyte CD14 significantly increased, cytokine significantly increased; concluded to limit use of PT.	IB
130	Lynn AM, Fischer T, Brandford HG, Pendergrass TW. Systemic responses to tourniquet release in children. Anesth Analg. 1986;65(8):865-872.	Nonexperimental	15 pediatric pt	n/a	n/a	lactate acid, SBP, Vital signs	Increase lactic acid persisted 10 minutes after deflation; recommend <75 min of inflation & releasing second pneumatic tourniquet within 60 minutes.	IIIC
131	Bloch EC, Ginsberg B, Binner RA Jr, Sessler DI. Limb tourniquets and central temperature in anesthetized children. Anesth Analg. 1992;74(4):486-489.	Quasi-experimental	47 pediatric pt	tourniquet-assisted procedures	unassisted extremity surgical procedures	temperature	Tourniquet procedures significantly increase temperature; recommend not aggressively warming pediatric patients in PT-assisted procedures.	IIB
132	Bloch EC. Hyperthermia resulting from tourniquet application in children. Ann R Coll Surg Engl. 1986;68(4):193-194.	Nonexperimental	56 pediatric pt	n/a	n/a	temperature	After 120 minutes, only tourniquet-assisted procedures have significant increased temperatures.	IIIC

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133	Estebe JP, Le Naoures A, Malledant Y, Ecoffey C. Use of a pneumatic tourniquet induces changes in central temperature. <i>Br J Anaesth</i> . 1996;77(6):786-788.	RCT	26 male pt	forced air warming	passive insulation v no tourniquet	temperature, esophageal versus rectal	Patient temperature decreased before inflation, significantly increased with pneumatic tourniquet inflation, significantly higher with forced air active warming at 30 minutes; temperatures significantly correlated with pneumatic tourniquet inflation time, SBP increased significantly, then decreased significantly after deflation, significant end tidal carbon dioxide & peak returned to baseline at 20 minutes post deflation; recommend further studies to confirm.	IC
134	Chon JY, Lee JY. The effects of surgery type and duration of tourniquet inflation on body temperature. <i>J Int Med Res</i> . 2012;40(1):358-365.	Nonexperimental	60 pt	n/a	n/a	core temperature after pneumatic tourniquet deflation, type of surgery, pneumatic tourniquet time	Pneumatic tourniquet time & type of surgery influence temperature, anesthesia should be aware of potential hypothermia in these patients.	IIIB
135	Standards, Guidelines, and Position Statements for Perioperative Registered Nursing Practice. 12th ed. Bath, ON: Operating Room Nurses Association of Canada; 2015.	Guideline	n/a	n/a	n/a	n/a	Recommendation to report inflation time to surgeons every 15 minutes after 1 hour.	IVB
136	Zarrouki Y, Abouelhassan T, Samkaoui MA. Cardiac arrest after tourniquet deflation in upper limb. <i>Trauma Case Rep</i> . 2017;7:1-2.	Case Report	n/a	n/a	n/a	n/a	Pneumatic tourniquet inflation lead to ischemia with metabolic changes including decreased oxygen, acid-base balance of lactic acid, carbon dioxide, potassium, & toxic metabolites; tourniquet deflation released toxins into circulation, which lead to myocardial stunning; researchers recommended duration & pressure parameters for safe PT use be followed.	VC
137	Huh IY, Kim DY, Lee JH, Shin SJ, Cho YW, Park SE. Relation between preoperative autonomic function and blood pressure change after tourniquet deflation during total knee replacement arthroplasty. <i>Korean J Anesthesiol</i> . 2012;62(2):154-160.	Nonexperimental	86 TKA	n/a	n/a	heart rate variability, SBP variability, baroreflex sensitivity (BRS)	Baroreflex sensitivity & SBP variability correlated with BP changes, low baroreflex sensitivity associated with hypotension & requires regulation intraoperatively.	IIIB

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138	Panerai RB, Saeed NP, Robinson TG. Cerebrovascular effects of the thigh cuff maneuver. <i>American journal of physiology. Heart and circulatory physiology</i> . 2015;308(7):H688-H696.	Nonexperimental	9 healthy volunteers	n/a	n/a	bilateral cerebral blood flow velocity, BP, end tidal carbon monoxide & dioxide, critical closing pressure, resistance area product, HR, & estimated & classical autoregulation index	There is a pure myogenic response without metabolic mechanism; autonomic neurological systemic response potentially from baroflex; no significant difference from PT inflation to just before deflation, researchers concluded that only PT deflation causes these changes.	IIIB
139	Tsunoda K, Sonohata M, Kugisaki H, et al. The effect of air tourniquet on interleukin-6 levels in total knee arthroplasty. <i>Open Orthop J</i> . 2017;11:20-28.	Quasi-experimental	20 PT; 5 cleaned	no PT	PT	temperature, Interleukin 6, C-reactive protein, Creatine Phosphokinase, white blood cells, preoply & at 24 hour postoply & postop day 7	No difference in DVT incidence, perioperative factors, operative time, or EBL; conclude pneumatic tourniquet not significant influence on patients' surgical stress response.	IIC
140	Kruse H, Christensen KP, Moller AM, Gogenur I. Tourniquet use during ankle surgery leads to increased postoperative opioid use. <i>J Clin Anesth</i> . 2015;27(5):380-384.	Nonexperimental	603 ankle procedures	n/a	n/a	pneumatic tourniquet time, opioid use within first 24 hours postoply, secondary peak pain visual analog scale every 15 minutes in the first postop hour, time in PACU, additional medications	Pneumatic tourniquet increased postop opioid use, had higher peak pain severity & longer PACU stay.	IIIA
141	Sahu SK, Tudu B, Mall PK. Microbial colonisation of orthopaedic tourniquets: A potential risk for surgical site infection. <i>Indian J Med Microbiol</i> . 2015;33 Suppl:115-118.	Quasi-experimental	16 pneumatic tourniquet, 4 areas each	Salvon cleaner	Sterillium cleaner	colonies counted & identified on morphology	All tourniquets were colonized & there was a 92-95% reduction in colony count with either cleaner; recommend routine disinfectant with alcohol-based solution.	IIB
142	State Operations Manual Appendix A: Survey Protocol, Regulations and Interpretive Guidelines for Hospitals. Rev 183. 2018. Centers for Medicare & Medicaid Services. https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/som107apa_hospitals.pdf . Accessed March 5, 2020.	Regulatory	n/a	n/a	n/a	n/a	Equipment must be monitored, inspected, tested, & maintained by biomedical program & laws, guidelines, & manufacturer's recommendations.	n/a
143	Medical device reporting (MDR): How to report medical device problems. US Food and Drug Administration. https://www.fda.gov/medical-devices/medical-device-safety/medical-device-reporting-mdr-how-report-medical-device-problems . Accessed March 5, 2020.	Regulatory	n/a	n/a	n/a	n/a	Regulatory requirements for reporting malfunctioning equipment.	n/a
144	Guideline for patient information management. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2020:357-386.	Guideline	n/a	n/a	n/a	n/a	Guidance on documentation as important to patient safety & continuity of care.	IVA