

Tourniquet-Related Hazard Reports from the Published Literature (Jan 1990 – Feb 1998)

Abstracts

Device: Pneumatic Tourniquets

Reference: Kumar SN, Chapman JA, Rawlins I. Vascular Injuries in Total Knee Arthroplasty. A Review of the Problem with Special Reference to the Possible Effects of the Tourniquet. *J of Arth* 1998 Feb; 13(2): 211-6

Abstract: Considering the proximity of the major vascular structures to the back of the knee, vascular complications of total knee arthroplasty are relatively rare. A patient who developed acute vascular insufficiency immediately following a total knee arthroplasty is reported. This stimulated a survey of arterial complications encountered by members of the British Association for the Surgery of the Knee. The majority of surgeons still use a tourniquet but will modify their practice if there is anxiety about vascular status. The mechanism of injury to the vascular system is either direct trauma or thrombosis. The outcome following treatment after direct injury is extremely good. The outcome after thrombosis is extremely poor. There is no recorded case of thrombosis occurring when a tourniquet was not used. Whether all knee arthroplasties should be done without a tourniquet is discussed. Early intervention is vital if a vascular injury is suspected. Keywords: vascular injury, knee arthroplasty, tourniquet, thrombosis.

Device: Pneumatic Tourniquets

Reference: Finsen V, Kasseth AM. Tourniquets in forefoot surgery. Less pain when placed at the ankle. *J Bone Joint Surg (Br)* 1997 Jan;79(1):99-101.

Abstract: The authors studied the effect of pneumatic tourniquet placement on pain and neurological complications in 49 patients undergoing forefoot surgery. Cuffs were placed either at calf level (n=24) or just above the ankle (n = 25), and mean pressures were almost identical. Operating surgeons reported a bloodless surgical field with both positions. Patients with ankle placement reported significantly less pain during the operation than those with calf placement; the authors hypothesize that this is because less

unanesthetized tissue becomes ischemic during tourniquet compression. The authors conclude that an ankle tourniquet is less painful with no increase in neurological complications.

Device: Pneumatic Tourniquets

Reference: Estebe JP, LeNaoures A, Malledant Y, et al. Use of a pneumatic tourniquet induces changes in central temperature. *Br J Anaesth* 1996 Dec;77(6):786-8.

Abstract: The authors studied the effect of prolonged limb tourniquet use on esophageal and rectal temperatures in 26 male adult patients undergoing orthopedic surgery. Tourniquets were used in 20 patients: 10 had the available skin surface covered with passive reflective insulation material and 10 were covered with a forced air warming system. 6 patients with contraindications or no indications for the use of the tourniquet were treated without the device. An increase in temperatures was seen in both tourniquet groups but not in the group without tourniquets, and temperatures continued to increase as long as the device was inflated. Rectal temperature changes were similar but significantly delayed when compared to esophageal temperature changes. Temperatures decreased rapidly following release of the tourniquet. An increase in arterial pressure during tourniquet use was also seen, as was an increase in end-tidal CO₂ at deflation. The authors postulate that the release of ischemic metabolites from the extremity into the bloodstream, possibly through bone, causes the increase in body temperature.

Device: Pneumatic Tourniquets

Reference: Uoyd SM, Reid J, Thorburn J. Failure to influence hypotension during spinal anaesthesia with a limb tourniquet. *Acts Anaesthesiol Scand* 1995 Jan;39(1):39-42.

Abstract: The authors investigated the effectiveness of using a thigh tourniquet to reduce hypotension in patients under going total hip replacement under spinal anesthesia. There was no significant difference between those patients with a thigh tourniquet and controls, with respect to systolic blood pressure or requirement of ephedrine, during the hour that the tourniquet was applied or the period immediately following the removal of the tourniquet. The authors discuss prophylactic and

restorative measures that may be taken to either prevent or treat hypotension caused by spinal anesthesia. The authors conclude that the use of a thigh tourniquet cannot be advocated for the prevention of hypotension in patients undergoing hip replacement under spinal anesthesia.

Device: (1) Tourniquets; (2) Total Knee Prostheses

Reference: Abdel-Salam A, Eyres KS. Effects of tourniquet during total knee arthroplasty: a prospective randomised study. *J Bone Joint Surg (Br Vol)* 1995 Mar;77(2):250-3.

Abstract: The authors examined the effects of using a tourniquet for total knee arthroplasty (TKA) in 80 patients randomly allocated to have TKA with or without a tourniquet. There was no significant difference between the 2 groups in operating time or total blood loss, but postoperative pain was less in the patients in whom a tourniquet had not been used. In addition, these patients achieved straight-leg raising and knee flexion earlier and had fewer superficial wound infections and deep vein thromboses. The authors conclude that TKA can be safely performed without the use of the tourniquet, avoiding the potential adverse effects associated with its use.

Device: (1) Tourniquets; (2) Total Knee Prostheses

Reference: Klenerman L. Is a tourniquet really necessary for total knee replacement? [letter]. *J Bone Joint Surg (Br Vol)* 1995 Mar;77(2):174-5.

Abstract: The author discusses 2 studies that report a reduced complication rate after knee arthroplasty performed without a tourniquet. There were 4 patients with deep vein thrombosis in the tourniquet group, but none in the group operated on without a tourniquet. The author states that there may be advantages in performing knee

replacements without a tourniquet; more trials of knee replacements with and without the use of a tourniquet are needed to establish the safest technique.

Device: Single-cuff Inflatable Tourniquets: (1) 8 cm, (2) 10 cm

Reference: Hoffmann AC, van Gessel E, Gamulin Z, et al. Quantitative evaluation of tourniquet leak during i.v. regional anaesthesia of the upper and lower limbs in human volunteers. *Br J Anaesth* 1995 Sep;73(3):269-73.

Abstract: The authors used radiolabelled N-(2,6-dimethylphenyl-carbamoxymethyl) iminodiacetic acid (HIDA) to determine the amount of leakage of anesthetic agent under inflated tourniquets during simulated intravenous regional anesthesia of the limb. In addition, they compared measurements taken from both the upper and lower limbs of 10 subjects. The decrease in radioactivity was measured with a gamma camera for the 20 minutes of tourniquet inflation and for the 20 minutes of washout after cuff deflation. Results demonstrated that there were significant leaks under the tourniquet in both locations; the leaks measured during tourniquet inflation were twice as great for the lower limb as for the upper limb. There was a rapid washout for both limbs when the tourniquet was deflated; however, washout from the upper limb was significantly more rapid than that from the lower limb. The authors note that there was no significant correlation between the amount of leak from either limb and individual patient characteristics, maximum venous pressure during injection, or maximum mean arterial pressure. They conclude that there is significant leakage of anesthetic agent under tourniquets placed on lower limbs and that this may result in a shorter duration of successful anesthesia and/or failure.

Device: Thigh Tourniquets

Reference: Maffulli N, Testa V, Capasso G. Use of tourniquet in the internal fixation of fractures of the distal part of the fibula. *J Bone Joint Surg (Am Ed)* 1993 May;75(5):700-3.

Abstract: Clinicians initiated a prospective randomized trial to determine the complication rate associated with the use of a thigh tourniquet during open reduction and internal fixation of simple, closed fractures of the distal part of the fibula. 80 patients were enrolled in the study, mean follow-up was 18 months. The patients were randomly assigned to 2 groups: in group 1 (40 patients), the tourniquet was used, and in group 2 (40 patients), the tourniquet was not used. The average duration of operation was significantly longer for group 2 than for group 1 (53 ±12 minutes versus 41 ±9 minutes, respectively). There were more complications in group 1, including isolated deep-vein thrombosis in 2 patients. The wound was possibly infected in 11 patients (7 in group 1 and 4 in group 2), and obviously infected in 3 patients in group 1. The plaster of paris cast required changing in 3 patients in group 1, and group 1 patients returned to work an average of one week later than those in group 2. The clinicians conclude that, due to the lower complication rate and shorter recovery time observed in those patients who did not receive a thigh tourniquet during surgery, the use of such a tourniquet is not justified in the operative treatment of simple fibular fractures; however, they note that a tourniquet should be available in case there is excessive bleeding or distorted anatomy necessitating better visualization of the operative field.

Device: (1) Epidural Catheters; (2) Ampules; (3) Anesthesia Syringes; (4) Anesthesia Vaporizers; (5) Spinal Needles; (6) Tourniquets

Reference: Fox MA, Webb RK, Singleton R. et al. Problems with regional anaesthesia: an analysis of 2000 incident reports. *Anaesth Intensive Care* 1993 Oct;21(5):646-9.

Abstract: There were 160 incidents associated with regional anesthesia among the first 2,000 incidents reported to the Australian Incident Monitoring Study (AIMS). They were categorized into 6 groups: epidural anesthesia (n=83), spinal anesthesia (n=42), brachial plexus blocks (n=14), intravenous local anesthesia (n=4), ocular blocks (n=3), and local infiltration (n= 14). During regional epidural anesthesia, problems involving devices included dural puncture possibly due to stiff radiopaque catheters or sticky glass syringes. During regional spinal anesthesia, device-related problems included drug error due to ampule "swap"

in 3 cases and due to the vaporizer being left on in 1 case. Postdural headache occurred in 1 of the 42 patients undergoing regional spinal anesthesia; in these cases, 22 G and 25 G spinal needles were used. 4 incidents during regional intravenous anesthesia involved tourniquet failure; in 1 case, the operator deflated the tourniquet cuff by mistake. The authors conclude that regional anesthesia is not without some risk to the patient and that operators should be alert to these possible risks.

Device: Pneumatic Tourniquets

Reference: Cohen JD, Keslin JS, Nili M. et al. Massive pulmonary embolism and tourniquet deflation. *Anesth Analg* 1994 Sep;79(3):583-5.

Abstract: The authors report a case of massive pulmonary embolism after tourniquet deflation in a 56-year-old woman undergoing open reduction and bone grafting. The surgery was uneventful; however, after the tourniquet was deflated, the patient developed profound sinus bradycardia of 30 bpm and hypotension. The authors state that, because of the potentially catastrophic sequelae of these emboli and the failure of conventional prophylactic measures to prevent thromboembolism in 100% of patients, the insertion of a Greenfield filter before major orthopedic surgery in certain high-risk patients in whom tourniquets are also used may be, justified. In addition, the routine intraoperative use of transesophageal echocardiography in these patient groups may be warranted to allow early and accurate diagnosis of sudden cardiovascular instability. The authors conclude that the use of pneumatic tourniquets appears to carry a risk of pulmonary thromboembolism.

Device: (1) Pneumatic Tourniquets; (2) Total Knee Prostheses

Reference: Parmet JL, Horrow JC, Singer R, et al. Echogenic emboli upon tourniquet release during total knee arthroplasty: pulmonary hemodynamic changes and embolic composition. *Anesth Analg* 1994 Nov;79(5):940-5.

Abstract: The authors determined the relationship between embolic patterns and alterations in pulmonary hemodynamics following tourniquet release during total knee arthroplasty (TKA) and embolic composition in a group of 34 patients undergoing 35 TKAs. The results are presented and discussed. The authors found an increase in pulmonary vascular resistance index in 75% of TKA patients (in those with large echogenic material). They state that fresh thrombus released into the circulation after tourniquet deflation occurs frequently and add

that heparin administration before tourniquet inflation may diminish embolic showers. The authors conclude that further investigation should focus on predictors of patient morbidity and mortality after TKA, more definitive identification of embolic composition, and the use of antithrombotic drugs in preventing thrombus formation during tourniquet inflation.

Device: Pneumatic Tourniquet Cuffs: (1) Standard (2) Wide Curved, (3) Wide Straight, Tourniquet Inflation Systems: (4) ATS 1000, (5) Kidde

Reference: Pedowitz RA, Gershuni OH, Botte MJ, et al. The use of lower tourniquet inflation pressures in extremity surgery facilitated by curved and wide tourniquets and an integrated cuff inflation system. *Clin Orthop* 1993 Feb;(287):237-44,

Abstract: The authors assessed the minimum cuff pressure needed to occlude arterial blood flow using curved and straight tourniquets on 60 patients and 26 healthy volunteers. Curved and wide tourniquets occluded blood flow at lower inflation pressures than both straight and narrower Cuffs; mean tourniquet inflation pressures of 183.7 mm Hg and 208 mm Hg were used during various surgical procedures of the arm and leg, respectively. Incomplete hemostasis was associated with elevated systolic blood pressure in several cases, but acceptable surgical hemostasis was achieved by incremental increase of the cuff inflation pressure. The authors comment that the choice of tourniquet cuff width and shape should be Individualized, taking into consideration the size and shape of the patient's limb and the specific demands of the operative procedure. They conclude that curved cuffs, wide cuffs, and integrated cuff inflation systems should facilitate the use of lower tourniquet inflation pressures in extremity surgery, potentially minimizing neuromuscular injury included by the pneumatic tourniquet.

Device: Thigh Tourniquets

Reference: (1) Myles P. High tourniquet a trigger for MH? (letter); (2) Pollock N, Hodges M, Sendall J. In reply. Tourniquet ischaemia and MH (reply). *Anaesth Intensive Care* 1993 Apr;21(2):255.

Abstract: The first author (1) comments that a recent case of malignant hyperthermia may be attributable to the thigh tourniquet worn by the patient. According to the first author, muscle

response to the ischemia produced by the tourniquet may be more extensive In patients with malignant hyperthermia; also, release of the tourniquet may result in precipitation of the disease (if it was not precipitated during the period Of tourniquet inflation). The first author believes that this possible relationship between tourniquet use and malignant hyperthermia would produce a cycle that may be aggravated by the stressful period in Intensive care. The second authors (2) reply that the first author's conjecture has not been documented with actual case histories and that it is unlikely that malignant hyperthermia is caused by tourniquet ischemia. The second authors recommend close observation Of all malignant hyperthermia patients both during and after surgery.

Device: (1) Arthroscopes; (2) Electromyography Units; (3) Tourniquets

Reference: Rodeo SA, Forster RA, Weiland AJ. Current concepts review. Neurological complications due to arthroscopy. *J Bone Joint Surg* 1993 Jun;75-A(6):917-26.

Abstract: The authors review the prevalence and etiology of specific neurological complications that have been reported after arthroscopy of the knee, shoulder, elbow, ankle, wrist, and hip. They also discuss the treatment of these complications and the use of methods to decrease the risk of neurological injury during arthroscopy. The 4 general types of neurological injury that may occur secondary to arthroscopy are direct injury to a nerve, compression secondary to compartment syndrome, tourniquet-related neurapraxia, and reflex sympathetic dystrophy. The authors describe what each injury is like, how it occurs, and in which nerve it occurs. Methods of avoiding injury are discussed, including correct placement of surgical portals to avoid direct injury, limitation of capsular punctures to decrease the risk of fluid extravasation, and use Of a tourniquet for short periods to avoid neurapraxia. The authors recommend nerve-conduction studies and electromyography to diagnose neurological complications that are not prevented by the above techniques. They also discuss nerve repair and nerve-grafting procedures to treat athroscopically damaged nerves.

analgesic agents or where bleeding is being controlled.

Date: September 1993

Device: Pneumatic Tourniquets

Reference: Feldman DL, Wigod M, Barwick W, et al. Tourniquet-related hypotension in venous stasis ulcer excision. *Ann Plast Surg* 1993 Jun;30(6):556-9.

Abstract: The authors report on 3 patients with tourniquet-related hypotension that occurred 10 to 15 minutes after tourniquet release after excision of venous stasis ulcers. All patients had histories of venous stasis changes, and 2 had histories of deep-vein thrombosis and pulmonary embolism. All patients responded rapidly to standard resuscitation measures. Postoperative testing for pulmonary embolus and myocardial infarction was negative in all patients. Wound cultures revealed no organisms in 1 patient, mixed Grampositive cocci in the second patient, and 10⁵ *Serratia marcescens* in the third patient. The authors hypothesize that the combined effect of tourniquet ischemia and venous stasis changes may cause hypotensive shock by (1) an endotoxic bolus upon tourniquet release; (2) pulmonary microembolization of platelet, fibrin, and leukocyte aggregates causing vasoactive substance release; and/or (3) synergistic effects of platelet-activating factor, which is a known mediator of endotoxic shock. To prevent tourniquet-related hypotension in such patients, the authors recommend (1) proximal to distal dissection of the ulcer with initial ligation of large veins, (2) pretreatment with steroids and/or platelet-activating factor antagonists, and/or (3) slow release of the pneumatic tourniquet.

Device: Bladders for Stille tourniquet Cuffs

Identifier: Batch Dates 1992-03 to 1993-06; units distributed in the UX

Manufacturer: Stille-Werner AB [1.576601, Box 47318, S- 100 74 Stockholm, Sweden (manufacturers: FRY Surgical International Ltd [1734021 Unit 17 Goldsworth Park Trading Estate, GU21 3BA Woking, Surrey, England (U.K distributor)

Abstract: The UK Department of Health issued a hazard alert for cuffs used with the Stille pneumatic tourniquet. There has been 1 report of the detachment of the supply hose from the spigot of a Stille tourniquet cuff during a Bier's block procedure and 1 report of failure when the device was being used to control bleeding. In both cases there was immediate loss of pressure, but staff were able to avert serious consequences. The department notes that, with the use of some local

Device: (1) Pneumatic Tourniquets; (2) Esmarch Bandages

Reference: Lee T, Tweed WA, Singh B. Oxygen consumption and carbon dioxide elimination after release of unilateral lower limb pneumatic tourniquets. *Anesth Analg* 1992 Jul; 75(1):113-7.

Abstract: The authors investigated the change in oxygen consumption (V_{O_2}) and carbon dioxide elimination (V_{CO_2}) after tourniquet deflation in unilateral lower-extremity surgery on 15 male patients, ages 15 to 43 years, requiring arthroscopic surgery for knee problems related to sports injuries and in 15 female patients, ages 41 to 71 years, requiring arthroscopic debridements due to degenerative diseases of the knee joints. The extremity undergoing surgery was exsanguinated with an Esmarch bandage, and the pneumatic tourniquet was inflated to a pressure of 450 mm Hg. Postoperative, deflation of the tourniquet resulted in an increase of V_{O_2} in the male patients of 89.6% \pm 21.3% and of 48.7% + 28.9% in the female patients. The increase of V_{CO_2} in the male patients was 46.5% \pm 41 % and in the female patients was 29.2% \pm 12.8%. Presumably, these increases were more pronounced in the younger male patients than the older female patients because of the differences in muscle mass, age, and type of surgery required. A weak correlation was found between tourniquet time and excess carbon dioxide elimination, but no correlation between tourniquet time and peak increase of carbon dioxide was seen. The authors recommend monitoring end-tidal carbon dioxide and transient increase in minute ventilation during tourniquet deflation in order to maintain normocapnea.

Device: Surgical Tourniquets

Reference: Fahmy NFL Blood pressure, plasma catecholamines, and plasma renin activity increase during tourniquet application in man. [Abstract]. *Anesthesiology* 1992 Sep; 77(3A):A551.

Abstract: The author studied the changes in plasma catecholamines, plasma renin activity, and circulation variables in 40 patients undergoing lower-extremity surgery with the application of pneumatic tourniquets. Significant increases in blood pressure were seen 45 minutes after tourniquet application in the 30 patients receiving general anesthesia and continued until the tourniquet was removed. A small but significant rise in blood

pressure was seen for the 10 patients receiving spinal anesthesia. No changes in blood pressure were demonstrated by a control group of 10 patients undergoing lower-extremity surgery without tourniquet application. Increases in levels of norepinephrine, epinephrine, and plasma renin activity occurred with tourniquet application in patients receiving general anesthesia and were correlated to the increases in blood-pressure. Blood chemical variables did not change in the patients receiving spinal anesthesia during tourniquet application or in the control group. The author believes that preexisting hypertension and increases in plasma norepinephrine and plasma renin activity are correlated with the increase in blood pressure seen during tourniquet application and that other humeral and/or hormonal factors may also be involved in these hemodynamic changes.

Device: Tourniquet Cuffs

Reference: Graham B, Breault MJ, McEwen JA, et al. Occlusion of arterial flow in the extremities at subsystolic pressures through the use of wide tourniquet cuffs. *Clin Orthop* 1993 Jan; (286):257-61

Abstract: To test the hypothesis that wide tourniquet cuffs will arrest arterial blood flow at levels of inflation that are much lower than those required by standard tourniquet cuffs, cuffs of varying widths were applied to the upper and lower extremities of 34 healthy, normotensive volunteers. Occlusion pressure was estimated by determining the level of cuff inflation at which the distal pulse became detectable by ultrasonic flowmetry. The occlusion pressure was inversely proportional to the ratio of tourniquet cuff width to limb circumference and was in the subsystolic range at a cuff width to limb circumference ratio above 0.5. The authors conclude that wide tourniquet cuffs can achieve an effective arrest of the regional arterial circulation at subsystolic pressures of inflation. They believe that wide cuffs may reduce the risk of tourniquet-induced injury to underlying soft tissues by lowering the inflation pressure required to secure a bloodless field.

Device: Pneumatic Tourniquet Cuffs

Reference: Tsai YC, Lai YY, Chang CL Comparison of the effect of EMLA cream, subcutaneous ring anaesthesia and a double cuff technique in the prevention of tourniquet pain. *Br J Anaesth* 1993 Apr;70(4):394-6.

Abstract: The authors compared EMLA topical anesthesia cream, subcutaneous ring anesthesia (SRA), and double tourniquet cuffs for the prevention of tourniquet pain among 40 adult patients undergoing intravenous regional anesthesia (IVRA) for elective forearm or hand surgery. The mean duration of analgesia for EMLA cream, SRA, double tourniquet cuffs, and control groups was 57.3 min, 54.1 min, 91.5 min, and 30.0 min, respectively. The mean duration of tolerance to tourniquet inflation for these same techniques was 72.3 min, 68.3 min, not evaluated, and 45.6 min, respectively. The authors conclude that the use of EMLA cream is associated with longer duration of tourniquet analgesia and tourniquet tolerance in comparison to a control group, but that the double cuff tourniquet technique provides more reliable analgesia at the tourniquet site.

Device: (1) Pneumatic Tourniquets: (2) Townley Knee Joint Prostheses

Reference: Hagan PF, Kaufman EE Vascular complication of knee arthroplasty under tourniquet. *Clin Orthop* 1990 Aug; (257):159-61.

Abstract: The authors encountered a rare complication when using a pneumatic tourniquet before performing a total knee arthroplasty. On the first postoperative day, an arterial occlusion due to a freshly formed thrombosis occurred. Before the dressing was applied, the patient's foot had an adequate vascular status. The authors listed several factors that increase the chances for this complication: prostatic carcinoma, estrogen therapy, age-related atherosclerotic disease, and the use of a tourniquet. The authors suggest that surgeons carefully consider these factors when using a pneumatic tourniquet. They also recommend that surgeons check for pedal pulses and capillary refill after cuff deflation.

Device: Tourniquets

Reference: Shenton DW, Spitzer SA, Mulrennan BM. Tourniquet-induced rhabdomyolysis. *J Bone Joint Surg* 1990 Oct; 72-A(9):1405-6.

Abstract: The authors reported a case of tourniquet-induced rhabdomyolysis. The padded thigh tourniquet was inflated to 325 mm of mercury and left in place for 1 hour and 27 minutes: after a 13 minute break, it was reinflated for an additional 1 hour and 46 minutes. Postoperatively, the patient developed hypoesthesia, weakness of the foot, dark-amber urine, and urinary urgency. An ortholdine test for myoglobin was positive, and rhabdomyolysis was diagnosed. The authors compared this case to 3 similar cases from the literature. They concluded that the clinical presentation of rhabdomyolysis is variable and that the physician should be alert to this complication.

Device: Thigh Tourniquets

Reference: Edwards A. Use of tourniquets [Letter]. *J Bone Joint Surg* 1992 Jan; 74-B(1): 164.

Abstract: The author agrees that complications and leg swelling after tourniquet removal are due to an ischemic-reperfusion injury (see referenced abstract). He notes that this is analogous to the situation found after a successful femoropopliteal arterial bypass procedure. The author comments that postoperative leg swelling after arterial surgery can be prevented by administering mannitol intraoperatively or by pretreatment with the free-radical scavenger allopurinol. He suggests that this approach may be of use to orthopedic surgeons who use tourniquets for prolonged periods of time.

Device: (1) Esmarch Rubber Bandages; (2) Tourniquet Cuffs

Reference: Crews JC, Denson DD, Hilgenhurst G. et al. Tourniquet Pain: The response to the maintenance of tourniquet inflation on the upper extremity of volunteers. *Reg Anesth* 1991 Nov-Dec; 16(6):314-7.

Abstract: The authors investigated the effect of tourniquet width, inflation pressure, and the application of the tourniquet to the left or right extremity on the intensity of tourniquet pain and duration of tourniquet inflation. The circulatory effects associated with inflation maintenance were also studied. Subjective descriptions of tourniquet pain from the 12 volunteers in this study included a rapidly accommodated sensation of pressure followed by progressive numbness and paralysis and a severe aching sensation at the site of the tourniquet. After deflation, the volunteers reported an intensely uncomfortable vibratory sensation.

The mean duration of inflation time in this study was 34 ± 13 minutes. No difference in discomfort was demonstrated with respect to tourniquet width inflation pressure, or the limb to which the tourniquet was applied.

Device: (1) Esmarch Bandages; (2) Transesophageal Echocardiographs

Reference: Sermeus L, Van Hemelrijck, Vandommele J. et al. Pulmonary embolism confirmed by transesophageal echocardiography. *Anaesthesia* 1992 Jan, 47(1):28-9.

Abstract: The authors report a case in which application of an Esmarch bandage to an immobilized leg resulted in pulmonary embolism. Mobilization of blood clots was suspected because of sudden hypotension, ECG changes, a decrease in end-expiratory carbon dioxide concentration, and oxygen desaturation as indicated by pulse oximetry. Transesophageal echocardiography confirmed the diagnosis, showing a severely hypokinetic, dilated right ventricle. 2 hours after the onset of symptoms, a substantial amount of thrombus was removed from both pulmonary arteries. The authors conclude that transesophageal echocardiography may be a useful tool for the confirmation of pulmonary embolus.

Device: Pneumatic Tourniquets

Reference: Hoka S, Yoshitake J, Arakawa S. et al. Vo₂ and VC_{O2} following tourniquet deflation. *Anaesthesia* 1992 Jan, 47(1):65-8.

Abstract. The authors examined changes in oxygen (O₂) uptake, carbon dioxide (CO₂) output, blood pressure, and heart rate following pneumatic tourniquet deflation in 23 patients undergoing orthopedic surgery of the lower extremities. A pneumatic tourniquet was applied for periods ranging from 21 minutes to 106 minutes. O₂ uptake and CO₂ output increased transiently following tourniquet deflation. CO₂ output increased more than O₂ uptake. Blood pressure fell significantly, and heart rate rose significantly. The authors conclude that pneumatic tourniquet deflation causes transient increases in O₂ uptake and CO₂ output proportional to the duration of tourniquet inflation. These changes may be of clinical significance in patients with impaired cardiopulmonary function.

Device: Tourniquets: (1) Arm; (2) Leg

Reference: des Reis Junior A. Tourniquet use and intraoperative hypothermia [Letter]. *Anesth Analg* 1989; 69(4):549-50.

Abstract: The author presents data suggesting arm or leg tourniquets may cause intraoperative hypothermia. Esophageal temperatures in 20 patients during knee surgery were measured. The esophageal temperature decreased an average of 0.33°C before tourniquet deflation and, 12 minutes after deflation, further decreased an average of 0.78°C. thereafter remaining stable. The author suggests that the following may account for the decrease in temperature: (1) the cooling effect of blood from the ischemic extremity reaching the systemic circulation; (2) cooling of systemic blood perfusing the hypothermic limb; and (3) reactive hyperemia in the involved extremity with cutaneous hyperemia leading to increased transcutaneous loss of heat. Further study is needed because of the dangers of inadvertent body hypothermia.

Device: Sterile Hose, used to extend the connection of an ATS (Automatic Tourniquet System) 1500 or ATS 500 Tourniquet Controller and the tourniquet cuff: (1) Single Hose; (2) Dual Hose
Identifier Catalog No.: (1) 60-40096-001, Lot No. A0989411; (2) 60-1812-001. Lot No. A098933; 44 cases (20 units/case) of (1) and 25 cases (20 units/case) of (2) distributed in the U.S. and in Canada. France. and Sweden

Reference: *FDA Enforcement Rep* 1990; Feb 28; Manufacturer.

Abstract: The Luer assembly (connector) on these hoses is installed backwards and does not allow connection of the hose assembly to the mating Luer on the tourniquet cuff. FDA Class 11 Recall No. Z-409/410-0; firm-initiated recall by letter December 21, 1989. This letter informed customers of the problem and provided recall instructions; a questionnaire was enclosed. Customers will receive credit or replacement for affected hoses. Check your stock and units in use for affected hose. Remove and return all affected hose to Zimmer Arthroscopy Systems. Complete and return the questionnaire provided. For more information, contact R.A. Vesey at (800) 343-9063; in Colorado and outside the U.S. (303) 799-0070. You may also contact your Zimmer Sales Representative.

Device: Sphygmomanometer Cuffs

Reference: Gower SN, Beaumont AC. A burst sphygmomanometer cuff during intravenous regional anaesthesia (Letter). *Anaesthesia* 1989; 44(12):1016-7.

Abstract: A sphygmomanometer cuff burst during intravenous regional anesthesia performed on a morbidly obese patient. A routine Bier's block was performed, but because the routine cuffs were not large enough, sphygmomanometer cuffs were used instead. After 12 minutes and with manipulation of the arm in progress, the cuff burst. The patient suffered no untoward effects. This case illustrates the need for suitable outsize equipment for use in the morbidly obese patient. The blood pressure cuff 13 not designed to withstand pressures of 270 mm Hg for long intervals or even higher pressures during manipulation of the arm, and the authors do not advise using the blood pressure cuff during this procedure.

Device: Tourniquets

Reference: Eldridge PR, Williams S. Effect of limb tourniquet on cerebral perfusion pressure in a head-injured patient. *Anaesthesia* 1989; 44(12):973-4.

Abstract: A multiple-trauma case is presented in which routine management of a lower-limb injury resulted in poor cerebral perfusion. The humerus of the injured patient was fixed internally, and then the knee ligaments were repaired in an exsanguinated limb with a tourniquet applied for approximately 90 minutes. The minimum safe cerebral perfusion pressure of 50 mm Hg was reached in this case, allowing only a small margin for error. The authors suggest perioperative monitoring of end-tidal pCO₂ and mean arterial pressure to identify the risk and indicate the efficacy of treatment in patients with multiple injuries. Patients should be volume-replete before tourniquet release. Moderate hyperventilation will be helpful as well.

Device: (1) Pneumatic Tourniquets ; (2)
Total Knee Joint Prostheses

Reference: Zahrani HA. Cuschieri RJ. Vascular complications after total knee replacement. J Cardiovasc Surg 1989; 30(6):951-2.

Abstract: 2 patients developed ischemia of the lower limb after ipsilateral total knee replacement. Both patients required a suprapatellar amputation as a result. Tourniquet time should not exceed 2 hours, and tourniquet use should be avoided wherever possible to reduce morbidity. Intraoperative manipulation may result in acute occlusion. Most patients who undergo total knee replacement are elderly and may have a combination of peripheral vascular disease and degenerative joint disease that may mask the severity of a vascular problem. The authors recommend full vascular evaluation as part of the preoperative assessment.

Device: Tourniquet Cuff Pressure Monitors: (1)
Electromedics Model TCPM: (2) DePuy Model
Medi-Quet 2740

Reference: *FDA Enforcement Rep 1990:* Oct 24; Manufacturer.

Abstract: A limited number of the tourniquet cuff pressure monitors were manufactured with an incorrect microprocessor timing chip, causing the device to show incorrect time. The affected units will count up to 99 minutes followed by an indication of 1 hour 00 minutes. The firm sent letters to customers on September 6, 1990, informing them of the possible problem. A response card was provided. Electromedics will repair affected units free of charge. FDA has designated this action Class 11 Recall Nos.Z-010/01 1-1. Verify that you have received the September 6, 1990, letter. Test your units by running the clock on your unit for longer than 60 minutes but less than 99 minutes. If the timer does not change to 1 hour after 60 minutes, when compared to a standard clock or stopwatch, do not use the unit. Complete and return the response form for all of the pressure monitors listed above. Electromedics will arrange for repair of any defective units free of charge. For further information, contact Karl Steineck. Electromedics Inc. at (800) 525-7055. international customers should contact their local distributors.