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CHAPTER 10.6

Lower Leg, Ankle, Foot, and Other Lower-Extremity Procedures

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Open Reduction and Internal Fixation (ORIF) of the Tibial Plateau Fracture

Surgical Considerations

Description: ORIF of the tibial plateau or proximal tibia fracture involves making a longitudinal incision along the proximal leg, lateral to the knee, obtaining a reduction by direct visualization of the fracture fragments, and applying plates and screws along the tibia for rigid internal fixation. An iliac crest bone graft may be necessary. A **proximal tibial osteotomy** involves correcting malalignment (valgus and varus) of the lower extremity by excising a wedge of bone from the tibia and correcting the mechanical axis.

Usual preop diagnosis: Tibial plateau or proximal tibial fracture; nonunion/malunion of the tibial plateau or proximal tibia; degenerative arthritis of the knee, with varus or valgus deformity

Summary of Procedures

	ORIF Tibial Plateau Fracture	Proximal Tibial Osteotomy
Position	Supine	
Incision	Lateral to knee, usually; medial, rarely	Transverse or lateral incision
Special instrumentation	Special plates, screws; reduction clamps; radiolucent table	
Unique considerations	Intraop radiographs or I.I.; tourniquet	
Antibiotics	Cefazolin or cefamandole 1 g iv q 6–8 h × 48 h	
Surgical time	2.5–3 h; more, depending on difficulty	
Closing considerations	Splint, cast while anesthetized	
EBL	< 200 mL	
Postop care	Multiple-trauma victim → ICU; others → PACU; ± CPM	PACU → ward
Mortality	Rare, except in severe multiple trauma	None
Morbidity	Compartment syndrome: 10–20% Wound infection: 7–15% DVT (symptomatic): 3–5% Delayed union, nonunion, malunion: < 5% Peripheral nerve damage: 3% Intraarticular fracture: 2% Hypotension (multiple trauma) Leg-length discrepancy Osteomyelitis, septic arthritis Respiratory distress and fat embolism Vascular complications	< 25% 2% 2% 0.2%

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Pain score	7	7

Patient Population Characteristics

Age range	Any age; fracture most common in younger trauma patients and elderly Degenerative arthritis of knee, < 60 yr
Male:Female	1:1
Incidence	Common
Etiology	Trauma: falls, motorcycle and motor vehicle accidents, industrial injuries Degenerative: arthritis of knee

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Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. (1059).

Suggested Readings

1. Aglietti P, Chambat P: Fractures of the knee. In *Surgery of the Knee.* Insall JN, ed. Churchill Livingstone, New York: 1984, 395–490.

2. Egol KA, Koval KJ: Fractures of the tibial plateau. In *Chapman's Orthopaedic Surgery,* 3rd edition, Vol I. Chapman MW, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 737–54.

3. LaVelle DG: Delayed union and nonunion of fractures. In *Campbell's Operative Orthopaedics,* Vol 3. Canale ST, ed. CV Mosby, St. Louis: 1998, 2579–2630.

4. Mize R, Johnson EE, Hohl M: Complications of fractures and dislocations of the knee. In *Complications in Orthopaedic Surgery,* 3rd edition. Epps CH Jr, ed. JB Lippincott, Philadelphia: 1994, 525–56.

5. Whittle AP: Malunited fractures. In *Campbell's Operative Orthopaedics.* Canale ST, ed. Mosby, St. Louis: 1998, 2537–78.

6. Wiss DA, Watson JT, Johnson EE: Fractures of the knee. In *Rockwood and Green's Fractures in Adults,* 4th edition. Rockwood CA Jr, Green DP, Bucholz RW, et al., eds. Lippincott-Raven, Philadelphia: 1996.

Intramedullary Nailing, Tibia

Surgical Considerations

Description: In intramedullary nailing of the tibia, a metal nail is placed into the medullary canal of the tibia to stabilize (or prevent) a fracture. The affected leg generally is placed in traction, on a fracture table, via stirrup or calcaneal pin. Following the incision, an awl is used to make an entry hole in the proximal metaphysis of the tibia, through which a guide wire is introduced. The guide wire is placed across the aligned fracture, and the nail is introduced and driven over the guide wire. Before nail insertion, the medullary canal often is reamed to allow use of a larger nail. Most nails are interlocked both proximally and distally with screws that pass from the bone through holes in the nail.

Usual preop diagnosis: Fracture, nonunion or malunion of the tibia

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Summary of Procedures

Position	Supine, on fracture table. Consider inducing anesthesia before moving patient.
Incision	Proximal longitudinal incision over the patellar tendon; stab wound for screws
Special instrumentation	Nails, screws, and insertion instruments; intramedullary reamers; I.I.
Antibiotics	Cefazolin 1 g iv preop
Surgical time	2 h
Closing considerations	No splint or cast
EBL	200 mL
Postop care	PACU → room
Mortality	Minimal
Morbidity	Compartment syndrome: < 5% Infection: < 2% Neuropraxia: < 1 %
Pain score	5

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Patient Population Characteristics

Age range	> 16 yr
Male:Female	5:1
Etiology	Trauma (95%); tumor (5%)
Associated conditions	Multiple trauma (50%); compartment syndrome (5%)

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Reading

1. Bucholz RW, Heckman JD, eds: *Rockwood and Green's Fractures in Adults,* 5th edition. Lippincott Williams & Wilkins, Philadelphia: 2001.

External Fixation, Tibia

Surgical Considerations

Description: Fractures of the tibia are fixed with percutaneous pins that are clamped to an external frame. Stainless steel pins are drilled into the proximal and distal fragments of the fracture through stab wounds in the skin and subcutaneous tissues. Usually 2–3 pins are placed on either side of the fracture. Pin clamps and an external frame are attached and the fracture aligned with the assistance of the I.I. or under direct vision. Following fracture alignment, the pin clamps and frames are tightened to hold fracture alignment. External fixation is often used with open fractures. **Small-pin fixators** (e.g., Ilizarov) are used for fracture fixation, leg lengthening, and treatment of bony defects. Wound irrigation and debridement often accompany application of the fixation frame.

Usual preop diagnosis: Tibial fracture; tibial nonunion or malunion; tibial shortening

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Summary of Procedures

Position	Supine
Incision	Stab wounds. Small-pin fixator may require metaphyseal incision for osteotomy.
Special instrumentation	Pins; fixation frame; I.I.
Antibiotics	Cefazolin l g iv preop
Surgical time	0.5–1 h Small-pin fixator: 3–5 h
Closing considerations	May be open fracture (usually left open)
EBL	50 mL; small-pin fixator, 100 mL
Postop care	PACU → room
Mortality	Minimal
Morbidity	Infection: 15% Compartment syndrome: < 2% Neuropraxia: < 1%
Pain score	2–3

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Patient Population Characteristics

Age range	All ages
Male:Female	5:1
Incidence	Common
Etiology	Trauma (95%); shortened limb (< 2%); ununited or malunited fracture (< 2%)
Associated conditions	Open fracture (95%); compartment syndrome (< 2%); congenital anomaly (< 1%)

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Reading

1. Bucholz RW, Heckman JD, eds: *Rockwood and Green's Fractures in Adults,* 5th edition. Lippincott Williams & Wilkins, Philadelphia: 2001.

Open Reduction and Internal Fixation (ORIF) of Distal Tibia, Ankle, and Foot Fractures

Surgical Considerations

Description: ORIF is nearly always required for displaced fractures involving the ankle or joints in the foot. A longitudinal incision is made over the fractured medial and/or lateral malleoli. Dissection is carried directly down to the bone and the fracture is identified and reduced under direct vision.

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Open fractures may require **irrigation and debridement.** The fractures are realigned under direct vision and fixed and stabilized with pins, plates, and/or screws. An intraop radiograph is obtained to confirm reduction and placement of hardware. The incisions are closed and a splint or cast is applied.

Usual preop diagnosis: Fracture of the distal tibia, ankle, or foot

Summary of Procedures

	ORIF Ankle	With Irrigation and Debridement
Position	Supine	
Incision	Longitudinal over fracture site	+ extension of existing wound
Special instrumentation	Pins, plates, and screws; tourniquet; x-ray or I.I.	
Antibiotics	Cefazolin 1 g iv preop	
Surgical time	2 h	2–3 h
Closing considerations	Splint or cast while anesthetized	Splint or cast; may leave wound open.
EBL	50 mL	100 mL
Postop care	PACU → room	
Mortality	Minimal	
Morbidity	Wound dehiscence: 10% Loss of reduction: 7% Infection: 3%	15%
Pain score	4	4

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Patient Population Characteristics

Age range	Infant–elderly (usually > 60 yr)
Male:Female	1:1
Incidence	250,000 cases/yr in the United States
Etiology	Trauma: 100%
Associated conditions	Alcohol abuse; obesity; diabetes mellitus (DM)

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Readings

1. Bucholz RW, Heckman JD, eds: *Rockwood and Green's Fractures in Adults,* 5th edition. Lippincott Williams & Wilkins, Philadelphia: 2001.

2. Carragee EJ, Csongradi JJ, Bleck EE: Early complications in the operative treatment of ankle fractures. Influence of delay before operation. *J Bone Joint Surg* 1991; 73(l):79–82.

3. Epps CH Jr, ed: *Complications in Orthopaedic Surgery,* 3rd edition. JB Lippincott, Philadelphia: 1994.

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Repair Nonunion/Malunion, Tibia

Surgical Considerations

Description: This procedure is used to treat a fracture that has not healed or was misaligned upon healing. The fracture is mobilized, usually grafted with autogenous or allograft bone, and realigned. With an anterior approach, a longitudinal incision is made anteromedial or anterolateral to the shaft of the tibia. Dissection is carried directly down to the bone and the nonunion identified. If the tibia is approached with a posterolateral incision, the patient is turned prone and a longitudinal incision is made just posterior to the fibula. Dissection is carried down posteriorly to the interosseous membrane, to the tibia, and the procedure becomes identical to the anterior approach. Tissue interposed between the bone ends may or may not be débrided. The cortex of the bone adjacent to the nonunion is roughened with an osteotome. Autogenous or allograft bone is placed adjacent to or in the nonunion site. In the case of a malunion, the bone may be osteotomized with a saw or osteotomes to allow realignment. If skeletal fixation is used, a plate may be attached to the bone through the same incision. Alternatively, an intramedullary nail may be placed through an incision anterior to the tibial tubercle. If an intramedullary device is used, the canal may be reamed with intramedullary reamers prior to placement of the nail. A third type of **skeletal fixation** is the external fixator that stabilizes the nonunion via percutaneous pins placed into the proximal and distal tibia, which are then spanned by a device with pin clamps at both ends. An intraop x-ray is often used to confirm fixation and placement of devices; alternatively, an I.I. may be used.

Variant procedure or approaches: Autogenous **bone grafting from the iliac crest** is commonly used to stimulate healing. An incision is made directly over the iliac crest and muscles are stripped from the crest and table of the ilium. Osteotomes and gouges are used to remove either the inner or outer table of the ilium and cancellous bone between the two tables. The wound is closed over a suction drain.

Usual preop diagnosis: Ununited or malunited fracture

Summary of Procedures

	Basic Repair	With Iliac Graft	With Skeletal Fixation
Position	Supine (prone with posterior lateral graft)		
Incision	Anteromedial or posterolateral to shaft of tibia	Anteromedial; parallel to iliac crest	
Special instrumentation	Tourniquet; x-ray or I.I.		Pins, plates, screws, rods, external fixator; tourniquet; x-ray or I.I.
Antibiotics	Cefazolin 1 g iv preop. (If infected nonunion anticipated, antibiotics are withheld until cultures are obtained.)		
Surgical time	2 h	2.5 h	3 h
Closing considerations	Splint or cast applied while anesthetized.		No splint or cast
EBL	100 mL	200–300 mL	
Postop care	PACU → room		
Mortality	Minimal		
Morbidity	Thrombophlebitis: 5% Compartment syndrome: 1% Infection: 1% Hematoma: < 1%	5%	1–3%
Pain score	5	8	5–8

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Patient Population Characteristics

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Age range	10–80 yr (usually 20–40 yr)
Male:Female	5:1
Incidence	5–10% of tibia fractures; 50–75% of open fractures
Etiology	Trauma: 100%
Associated conditions	Poor nutrition (50%); infection (10%); metabolic disease (10%)

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Readings

1. Csongradi JJ, Maloney WI: Ununited lower limb fractures. *West J Med* 1989; 150(6):675–80.

2. Epps CH Jr, ed: *Complications in Orthopaedic Surgery,* 3rd edition. JB Lippincott, Philadelphia: 1994.

3. Goulet JA, Hak DJ: Nonunions and malunions of the tibia. In *Chapman's Orthopaedic Surgery,* 3rd edition, Vol I. Chapman MW, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 977–1000.

Arthroscopy of the Ankle

Surgical Considerations

Description: Ankle arthroscopy is usually a diagnostic procedure, although it may be used for debridement or removal of loose bodies. The ankle joint generally is inspected through anterolateral and anteromedial portals (entry *(Print pagebreak 1038)* wounds). Posterolateral and posteromedial portals also may be used. Each portal is made via a 5-mm stab wound in the skin (Fig. 10.6-1); then instrumentation is placed, using trochars. If the ankle joint is tight, a mechanical distractor (external fixator distraction apparatus spanning the ankle joint) may be used. The distractor is attached to the bones via percutaneous pins, as in the case of the application of an external fixator. The portals are closed with sterile tape or a single suture. **Debridement** may be used to reduce local or generalized articular damage.

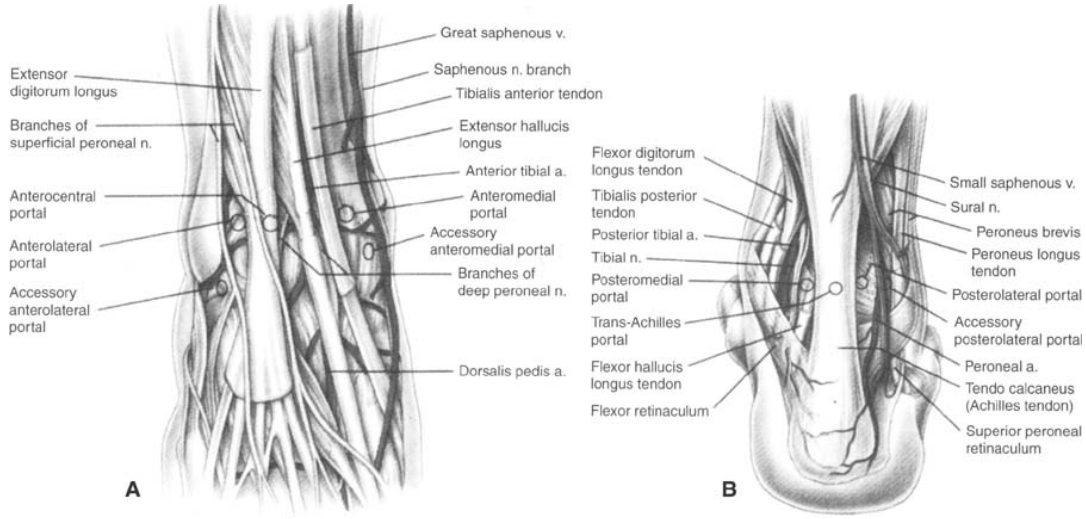

Figure 10.6-1. 1. Portals for ankle arthroscopy. **A:** Anterior anatomy and portals. The anterolateral and anteromedial portals are used routinely. **B:** Posterior anatomy and portals. The posterolateral portal also is used routinely. (Reproduced with permission from Ferkel RD: *Arthroscopic Surgery: The Foot and Ankle.* Lippincott-Raven, 1996.)

Usual preop diagnosis: Trauma; infection; arthritis

Summary of Procedures

	Arthroscopy	Arthroscopy + Debridement
Position	Supine	
Incision	0.5 cm portals (incisions)	
Special instrumentation	Arthroscopic video system; small biters and graspers	+ shaver
Unique considerations	± Tourniquet. May use distractor with pins through tibia and calcaneus.	
Antibiotics	Cefazolin 1 g iv preop (optional)	
Surgical time	1 h	1–2 h
Closing considerations	No splint; incisions injected with local anesthetic.	
EBL	Minimal	50 mL
Postop care	PACU → home	
Mortality	< 0.01%	
Morbidity	Hemarthrosis: 5% Thrombophlebitis < 2% Infection: < 1%	
Pain score	2–3	3

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Patient Population Characteristics

Age range	12–70 yr (usually 20–40 yr)
Male:Female	1:1
Incidence	Uncommon
Etiology	Trauma (70%); arthritis (20%); infection (5%)
Associated conditions	Usually healthy; may have systemic arthritis.

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Readings

1. Ferkel RD, McGrath SJ: Arthroscopy of the ankle. In *Chapman's Orthopaedic Surgery,* 3rd edition, Vol 3. Chapman MW, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 2441–66.

2. Lui TH: Arthroscopy and endoscopy of the foot and ankle: indications for new techniques. *Arthroscopy* 2007; 23(8):889–902.

3. McGinty JB, ed: *Operative Arthroscopy,* 3rd edition. Lippincott Williams & Wilkins, New York: 2002.

Ankle Arthrotomy

Surgical Considerations

Description: Arthrotomy of the ankle is the opening of the joint for drainage, debridement, or fracture treatment. The joint usually is opened with an anterolateral midline or anteromedial longitudinal incision. Tendons and neurovascular structures are carefully retracted to expose the joint capsule, which is then opened in line with the skin incision. After intra-articular pathology is addressed, careful closure of the capsule is performed, taking care to obtain good hemostasis.

Usual preop diagnosis: Infection; trauma; arthritis

Summary of Procedures

Position	Supine
Incision	Anterior midline or anteromedial longitudinal
Special instrumentation	Tourniquet
Antibiotics	Cefazolin 1 g iv preop
Surgical time	1–2 h
Closing considerations	± Splint while anesthetized; may have suction drain.
EBL	Minimal
Postop care	PACU → room
Mortality	Minimal
Morbidity	Hemarthrosis: 20% Thrombophlebitis: 5% Infection: 1%
Pain score	5

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Patient Population Characteristics

Age range	Infant – elderly
Male:Female	1:1
Incidence	Rare
Etiology	Trauma (70%); arthritis (20%); infection (10%)
Associated conditions	Inflammatory arthritis; multiple trauma; immunosuppression

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Reading

1. Crenshaw AH, ed: *Campbell's Operative Orthopaedics,* 10th edition. Mosby, St. Louis: 2003.

Ankle Arthrodesis

Surgical Considerations

Description: An **ankle fusion** may need to be performed for severe pain 2° arthritis of the ankle. In most cases, an anterior

approach is made to the ankle joint. An alternative approach is through the medial malleolus. The ankle joint is exposed and the surfaces of the joint are débrided either with osteotomes or a burr. Cancellous bone is exposed on the distal tibia and talus, and the joint is clamped together either with a simple external fixation device with pins going through the distal tibia and talus, or with bone screws that go from the distal tibia into the talus. The wound is closed over a drain, and a splint may be applied.

Usual preop diagnosis: Arthritis of the ankle

Summary of Procedures

Position	Supine
Incision	Anterior midline over distal tibia
Special instrumentation	Tourniquet; external fixator or bone screws
Unique considerations	Intraop radiographs; tourniquet use
Antibiotics	Cefazolin 1 g iv preop
Surgical time	2 h
Closing considerations	May be splinted; suction drain.
EBL	100 mL
Postop care	PACU → room
Mortality	Minimal
Morbidity	Nonunion (late): 15% Thrombophlebitis: 10% Hematoma: 5% Wound dehiscence: 5% Infection: 1%
Pain score	8

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Patient Population Characteristics

Age range	All adult
Male:Female	1:1
Etiology	Degenerative arthritis; trauma; avascular necrosis of talus; septic arthritis
Associated conditions	Inflammatory arthritis; any disease requiring steroids

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Readings

1. Chapman MW, ed: *Operative Orthopaedics.* 3rd edition. Lippincott Williams & Wilkins, Philadelphia: 2000.

2. Crenshaw AH, ed: *Campbell's Operative Orthopaedics,* 10th edition. Mosby, St. Louis: 2003.

Repair/Reconstruction of Ankle Ligaments

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Surgical Considerations

Description: Lateral ankle ligaments may be repaired acutely, but generally are reconstructed at a later date, if necessary, with the peroneus brevis used in most reconstructions. An incision is made posterior to the distal fibula, curving around the lateral malleolus and ending in the anterolateral foot. The peroneus brevis tendon is identified and detached from its musculotendinous junction in the leg, and the peroneus brevis muscle is sutured to the peroneus longus tendon. A hole is drilled from anterior to posterior in the distal lateral malleolus; then the detached end of the peroneus brevis tendon is threaded through the hole. It is then attached to either the calcaneus or the talus, anterior to the lateral malleolus, with a staple or by suturing into a hole in the bone. The skin and subcutaneous tissues are closed and a splint or cast is applied.

Usual preop diagnosis: Lateral instability of the ankle

Summary of Procedures

Position	Supine or lateral decubitus
Incision	Posterolateral aspect of ankle
Special instrumentation	Bone staples; tourniquet
Antibiotics	Cefazolin, 1 g iv preop
Surgical time	2 h
Closing considerations	Splint or cast while still anesthetized.
EBL	Minimal
Postop care	PACU → room or home
Mortality	Minimal
Morbidity	Infection: < 1% Rerupture: < 1% Wound dehiscence: < 0.1%
Pain score	5

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Patient Population Characteristics

Age range	Young adults
Male:Female	2:1
Etiology	Ankle sprain
Associated conditions	Alcohol abuse; obesity; diabetes mellitus (DM)

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Readings

1. Epps CH Jr, ed: *Complications in Orthopaedic Surgery,* 3rd edition. JB Lippincott, Philadelphia: 1994.

2. Marder RA: Ankle ligament injuries. In: *Chapman's Orthopaedic Surgery,* 3rd edition, Vol 3. Chapman MW, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 2473–84.

Amputation Through Ankle (Syme)

Surgical Considerations

Description: Syme's amputation (Figs 10.6-2, 10.6-3) is ankle disarticulation with closure, using a posterior flap, including the heel pad. It is more functional than below-knee amputation, because patients can bear weight on the *(Print pagebreak 1043)* end of the stump; however, success is poor in patients with vascular disease or peripheral neuropathy. The posterior flap is dissected directly from the calcaneus, carefully preserving the tough heel pad and its blood supply. The heel pad is sutured directly to the distal tibia to prevent migration and to cover the bone end. The posterior flap is then sutured to the anterior flap with interrupted sutures and a compression dressing applied.

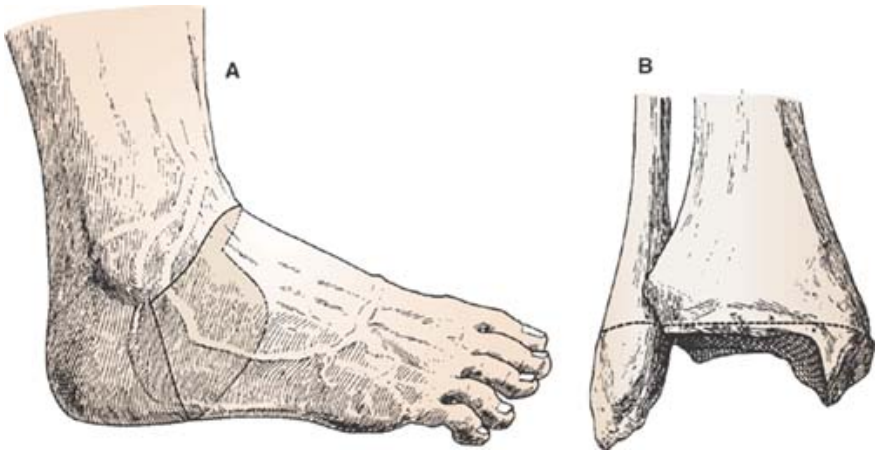

Figure 10.6-2. 2. Syme's amputation. **A:** Skin incisions. **B:** Level of bone transection in adults. (Reproduced from Bohne WHO: *Atlas of Amputation Surgery.* Thieme Medical, 1987.)

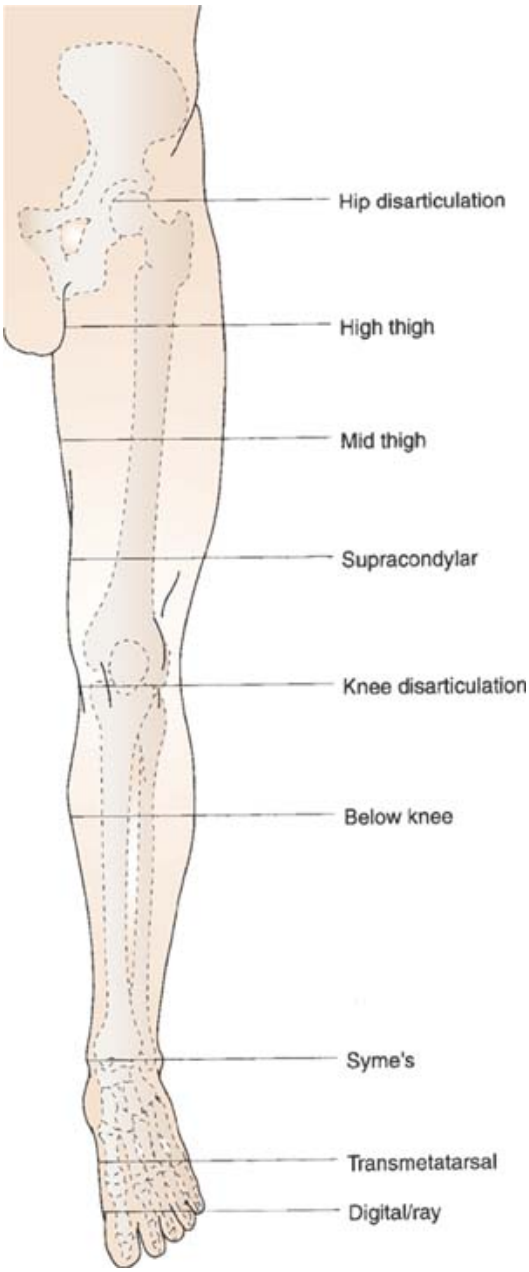

Figure 10.6-3. 3. Common amputation levels for the lower extremity. (Reproduced with permission from Greenfield LJ, et al: *Surgery: Scientific Principles and Practices,* 3rd edition. Lippincott Williams & Wilkins, 2001.)

Usual preop diagnosis: Trauma; infection

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Summary of Procedures

Position	Supine
Incision	Anterior and posterior flaps
Special instrumentation	Tourniquet
Antibiotics	Cefazolin 1 g iv preop
Surgical time	1.5–2 h
Closing considerations	Bulky dressing; if infection present, wound may be left open.
EBL	100 mL
Postop care	PACU → room
Mortality	Minimal

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Morbidity	Phantom pain: 90% Infection: 10–15% Wound breakdown: 10–15% Pneumonia: 12% MI: 7% PE: 6% Hematoma: 5% Stroke: 5%
Pain score	5

Patient Population Characteristics

Age range	Typically, > 60 yr
Male:Female	3:1
Incidence	20,000–30,000/yr
Etiology	Trauma (50%); infection (30%); congenital anomaly (5%)
Associated conditions	Peripheral vascular disease (30–40%); diabetes mellitus (DM) (< 20%)

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Readings

1. Bohne WHO, Ertl JP: Amputations of the lower extremity. In *Chapman's Orthopaedic Surgery,* 3rd edition, Vol 3. Chapman MW, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 3157.

2. Epps CH Jr, ed: *Complications in Orthopaedic Surgery,* 3rd edition. JB Lippincott, Philadelphia: 1994.

Amputation, Transmetatarsal

Surgical Considerations

Description: This amputation, usually for infection or ischemic necrosis of the toes, is performed at the midmetatarsal level, leaving the patient able to walk without a prosthesis. A transverse dorsal incision is made at the *(Print pagebreak 1045)* transmetatarsal level, and a plantar incision is made beginning at the corners of the dorsal incision and extending distally to the metatarsal heads to create a long plantar flap. The plantar flap is reflected proximally to the midmetatarsal level and tapered distally. The metatarsals are sectioned with a saw, and nerves and tendons are sectioned proximal to the osteotomies. The plantar flap is then brought over the ends of the bones and sutured with interrupted sutures to the dorsal flap. A compression dressing is applied.

Variant procedure or approaches: Other partial-foot amputations, such as **midtarsal** and **ray amputation,** are much less common. They are managed in a fashion similar to that of the transmetatarsal amputation.

Usual preop diagnosis: Gangrene of the toes; infection

Summary of Procedures

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Position	Supine
Incision	Dorsal and plantar flaps
Special instrumentation	Tourniquet
Antibiotics	Cefazolin 1 g iv preop
Surgical time	1–2 h
Closing considerations	Bulky dressing
EBL	50 mL
Postop care	PACU → room
Mortality	Minimal
Morbidity	Phantom pain: 90% Infection: 10–15% Wound breakdown: 10–15% Hematoma: 5%
Pain score	5

Patient Population Characteristics

Age range	> 60 yr
Male:Female	3:1
Incidence	20,000–30,000 total amputations/yr
Etiology	Vascular disease (70%); infection (25%) trauma (< 5%); congenital anomalies (< 1%)
Associated conditions	Vascular disease (70%); diabetes mellitus (30%); pulmonary disease (30%)

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Readings

1. Bohne WHO, Ertl JP: Ampuations of the lower extremity. In *Chapman's Orthopaedic Surgery,* 3rd edition, Vol 3. Chapman MW, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 3152–5.

2. Canale ST, ed: *Campbell's Operative Orthopaedics,* 10th edition. Mosby, St. Louis: 2003.

3. Epps CH Jr, ed: *Complications in Orthopaedic Surgery,* 3rd edition. JB Lippincott, Philadelphia: 1994.

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Lengthening or Transfer of Tendons, Ankle, and Foot

Surgical Considerations

Description: In cases of motor imbalance from neuromuscular disease or trauma, tendons are lengthened or transferred to a new insertion to partially restore balance or normalize joint motion. For **tendon lengthening,** a longitudinal incision generally is made directly over the tendon. Subcutaneous tissues and tendon sheath are incised to expose the tendon, which is transected with a Z-type incision. The tendon is placed in its lengthened position and the ends of the Z are closed with absorbable suture. If present, the tendon sheath is closed separately from the skin closure. In a **tendon transfer,** the tendon usually is cut close to its insertion and transferred to a new bony insertion, which often requires a separate incision. The tendon is attached to the bone either with a metal

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staple or by suturing it into a drill hole in the bone.

Variant procedure or approaches: Achilles tendon lengthening is used to bring the ankle out of equinus. A **posterior tibial tendon lengthening** and/or **posterior ankle capsulotomy** may accompany the procedure.

Usual preop diagnosis: Contracture of muscle

Summary of Procedures

	Tendon Lengthening	Achilles Tendon Lengthening
Position	Supine	Prone
Incision	Over tendon; sometimes multiple incisions	Over tendon
Special instrumentation	Tourniquet	
Antibiotics	If young, none; in elderly or infirm, cefazolin 1 g iv preop	
Surgical time	2 h	1 h
Closing considerations	Splint or cast while anesthetized	
EBL	10 mL	
Postop care	PACU → room	PACU → room or home
Mortality	Minimal	
Morbidity	Infection: < 1 %	
Pain score	4	3

Patient Population Characteristics

Age range	Any age
Male:Female	1:1
Incidence	Rare
Etiology	Neuromuscular disease (80%); trauma (20%)
Associated conditions	Static encephalopathy/cerebral palsy (75%); other neuromuscular disease (25%)

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

(Print pagebreak 1047)

Suggested Reading

1. Canale ST, ed: *Campbell's Operative Orthopaedics,* 10th edition. Mosby, St. Louis: 2003.

Amputation Above the Knee

Surgical Considerations

Description: In above-the-knee amputations, the distal part of the lower extremity is excised, starting just above the knee at the

level of the distal third of the femur (Fig. 10.6-3). A stump is fashioned, and will require prosthetic fitting at a later time. The most commonly performed stumps incorporate anterior and posterior flaps of equal length. The underlying muscles (hamstrings and quadriceps) are either sewn to each other (**myoplasty**) or to bone (**myodesis**). In a **guillotine,** or **open amputation,** the stump is not fashioned (tissues are not closed) until later. This is a multistage procedure used for dirty, traumatic amputations, infection, or above-knee amputations with questionable survival, and usually is done as a life-saving measure. Internal fixation of part of the remaining femur may be indicated in traumatic amputations. The patient returns to the OR every 1–3 d for redebridement until closure of the clean stump can be performed.

Usual preop diagnosis: PVD or gangrene of lower extremity; trauma to lower extremity; open-femur fracture with traumatic amputation; tumor of lower extremity

Summary of Procedures

Position	Supine
Incision	Anterior and posterior on thigh
Special instrumentation	Amputation saw and rasp; drill for myodesis
Unique considerations	Patient often very ill from sepsis, chronic disease, or trauma
Antibiotics	Cefazolin or cefamandole 1 g iv q 6–8 h), ± gentamicin (80 mg iv q 8 h); adjust dosage for renal status, ± penicillin (1–2 million U iv q 4 h).
Surgical time	1–2 h
Closing considerations	Compressive dressing ± special stump sock
EBL	250 mL or more; higher for traumatic amputations
Postop care	Generally PACU → room (if medically unstable → ICU)
Mortality	Approximately 10–20%; higher in PVD (10–39%)
Morbidity	Phantom limb: 85–95% Phantom pain: 2–15% Wound infection ± deep infection: < 15% in PVD Respiratory failure or pneumonia: 10–15% MI: 7–10% Thromboembolism: 6–10% Cerebrovascular accident: 5–10% Contractures – flexion and abduction: Common Urinary retention requiring catheterization: Common Failure to heal ± wound dehiscence: Uncommon Hematoma: Rare Neuromas: Rare Reamputation: Rare UTI: Rare Contralateral amputation, especially in diabetics and those with PVD Postop depression
Pain score	7–10

(Print pagebreak 1048)

Patient Population Characteristics

Age range	PVD, diabetic gangrene: 70–90% > 60 yr Multiple trauma with traumatic amputation, tumor of lower extremity: 18–35 yr
Male:Female	Overall, 3:1 Elderly, predominance of males Multiple trauma, 4–5:1 Tumor 1:1

Incidence	Common for PVD patients; rare for trauma or tumor
Etiology	PVD and diabetic gangrene (70–90%); multiple trauma (younger patients) (rare—usually with severe grade IIIC injuries with neurovascular severance); tumor (rare); uncontrollable infection (e.g., gas gangrene) (rare)
Associated conditions	Diabetes (70–80% of patients presenting for this procedure); numerous other serious medical conditions; multiple trauma in younger patients

Anesthetic Considerations

See Anesthetic Considerations for Above- and Below-Knee Amputation, p. 1050.

Suggested Readings

1. McCollough NC III, Epps CH Jr, Banks WJ Jr: Complications of amputation surgery. In *Complications in Orthopaedic Surgery,* 3rd edition. Epps CH Jr, ed. JB Lippincott, Philadelphia: 1994, 1279–1308.

2. Swiontkowski MF, Post PA: Surgical approaches to the lower extremity. In *Chapman's Orthopaedic Surgery,* 3rd edition, Vol I. Chapman MW, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 29–52.

3. Tooms RE: Amputations of lower extremity. In *Campbell's Operative Orthopaedics,* Vol 1, 9th edition. Canale ST, ed. Mosby-Year Book, St. Louis: 1998, 532–41.

Amputation Below The Knee

Surgical Considerations

Description: Below-the-knee amputation is ablation of the lower limb, usually at the level of the midleg. A long, posterior flap normally is used to cover the stump. The condition of the soft tissues may dictate the level and/or type of flaps used. The procedure begins with an anterior transverse incision made over the midtibia. A long posterior flap, which is 2–3 times the diameter of the leg in length, is then made. The bone is exposed anteriorly and the anterolateral neurovascular structures and muscles are transected and ligated as appropriate (Fig. 10.6-4A). The bone is then transected with a bone saw, and the posterior structures are transected and ligated as appropriate. The amputated leg and foot are then removed from the table and the posterior flap is tapered and shaped for closure (Fig. 10.6-4B). Deep sutures are placed to secure the posterior muscles to the anterior tibia. The skin opening and subcutaneous tissues are closed with interrupted sutures. Finally, a drain is placed (sometimes), and either a compression dressing or an immediate postop cast is applied.

Variant procedure or approaches: Guillotine amputation may be used as the first of a two-stage procedure in infected or contaminated cases. With a guillotine amputation, the bone and soft tissues are transected very quickly in guillotine fashion at the midtibial level. Neurovascular structures are ligated as appropriate. These wounds are usually left open and a compression dressing applied.

Usual preop diagnosis: Dysvascular limb; infection; trauma

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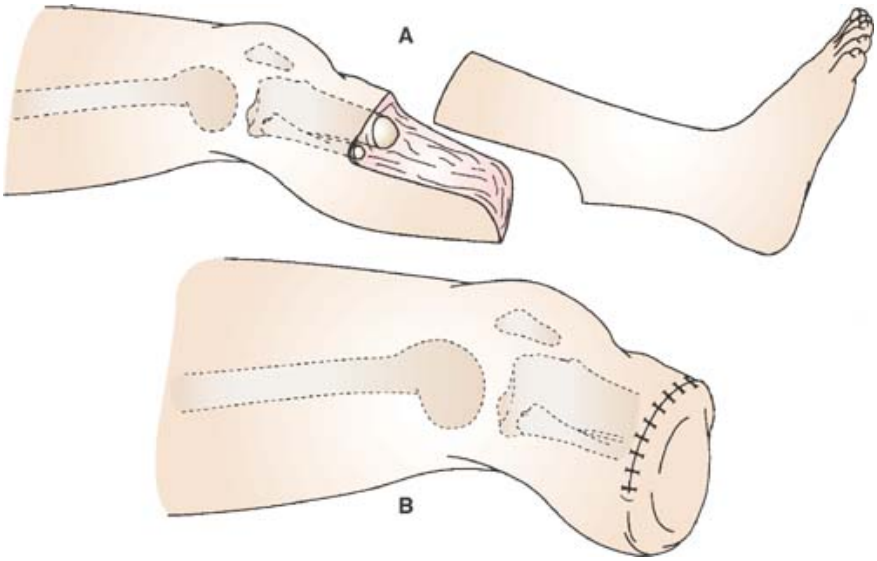

Figure 10.6-4. 4. Below-knee amputation. **A:** The tibia is transected 1 cm proximal to the skin incision, and the fibula is transected an additional 1 cm proximal to the level of the tibial transection. The posterior calf muscles are incised along the plane of the skin incision. **B:** The posterior flap is rotated anteriorly and approximated. (Reproduced with permission from Greenfield LJ, et al, eds: *Surgery: Scientific Principles and Practice,* 3rd edition. Lippincott Williams & Wilkins, 2001.)

Summary of Procedures

Position	Supine
Incision	Anterior and posterior flaps; for guillotine amputation, circumferential incision
Special instrumentation	Bone saw; tourniquet, if traumatic (tourniquet contraindicated if infected or avascular)
Antibiotics	Cefazolin 1 g iv preop
Surgical time	1.5 h; for guillotine amputation, 0.5 h
Closing considerations	May use cast; drain. Bulky dressing needed for guillotine amputation.
EBL	200 mL
Postop care	PACU → room
Mortality	10%
Morbidity	Phantom pain: 90% Infection: 10–15% Wound breakdown: 10–15% Pneumonia: 12% MI: 7% PE: 6% Hematoma: 5% Stroke: 5%
Pain score	5

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Patient Population Characteristics

Age range	Usually, > 60
Male:Female	3:1
Incidence	20,000–30,000 total amputations/yr

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Etiology	Dysvascular limb (70%); trauma (20%); infection (5%); tumor (5%); congenital anomaly (< 1%)
Associated conditions	Vascular disease (70–80%); malnutrition (50%); diabetes mellitus (30%); pulmonary disease (30%)

Anesthetic Considerations for Above- and Below-Knee Amputation

Preoperative

Vascular disease and tumors are the two most common indications for these surgeries. Patients presenting for amputations often have severe systemic vascular disease. Their inability to perform exercise limits the usefulness of preop Hx in evaluating cardiopulmonary reserve, and often necessitates invasive studies for full evaluation.

Respiratory	Smoking is a risk factor common to both vascular and pulmonary diseases. Chronic bronchitis or COPD patients should have maximum medical therapy (e.g., inhaled bronchodilators, theophylline and steroids, when appropriate) prior to anesthesia. Regional anesthesia is an excellent choice for patients with severe pulmonary disease. **Tests:** As indicated from H&P.
Cardiovascular	Significant cardiovascular disease is present in 30% of these patients. Particularly in diabetics, CAD is often silent. Dipyridamole thallium imaging of the heart can reveal the preop myocardium at risk of ischemia; however, therapy of stenotic coronary arteries usually can be undertaken only after the amputation. Medical management, to include β-blockers when tolerated, will reduce perioperative MIs. **Tests:** ECG; others as indicated from H&P.
Neurological	Peripheral and autonomic neuropathies may be present in the diabetic patient. Hence, these patients may be more susceptible to injury from malpositioning and are less able to tolerate the hemodynamic changes associated with regional anesthesia. Preexisting neurological deficits should be carefully documented. Autonomic neuropathy is diagnosed by any of the following: postural ↓ BP (in patient not bedridden); loss of sinus arrhythmia; resting ↑ HR; miosis–abnormal response to darkness.
Musculoskeletal	Rhabdomyolysis can occur in the presence of partial ischemia. (See Renal, below.)
Hematologic	Often a trial of heparin, warfarin, or thrombolytic therapy will have been undertaken before amputation. Coag studies, including PT, PTT, and bleeding time are, therefore, often necessary to determine the appropriateness of epidural or intrathecal anesthesia. Warfarin-induced elevation of the PT can be reversed preop with FFP 5–10 mL/kg body weight. This therapy may induce fluid overload in patients with poor cardiac reserve. For these patients, diuretics should be administered to maintain normovolemia. **Tests:** As indicated from H&P.
Renal	Limb ischemia can result in myoglobinemia from rhabdomyolysis. Evidence of progressive renal failure or rising CPK-MM fractions should be treated with hydration, forced alkaline diuresis and prompt amputation. **Tests:** Consider Cr; BUN; CPK enzymes; urine myoglobin.
Laboratory	Diabetic patients require preop control of blood glucose and periop glucose monitoring.
Premedication	Standard premedication (see p. B-1).

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Intraoperative

Anesthetic technique: Either regional or GA may be appropriate.

Regional anesthesia: Both SAB and epidural blocks are useful techniques. Subarachnoid anesthesia has the advantage of limited spread of the block above the level of surgery, while obtaining adequate blockade of the sacral roots that are resistant to low-dose epidural techniques. Epidural anesthesia allows for extending the duration of anesthesia and for the administration of postop epidural analgesia. Anesthesia from T12 (T8 with tourniquet) is adequate. Full motor blockade is not necessary. Typical drugs and doses include: subarachnoid—75 mg of 5% lidocaine in 5% dextrose (controversial) with morphine 0.2 mg; epidural—12–15 mL 2% lidocaine with epinephrine 1:200,000 in divided doses.

General anesthesia:

Induction		Standard induction (see p. B-2) is appropriate for patients with normal airways. Intubation is indicated for diabetic patients with gastroparesis. Beware of difficult airway in long-standing insulin-dependent diabetics.
Maintenance		Standard maintenance (see p. B-2).
Emergence		No special considerations
Blood and fluid requirements	Moderate blood loss IV: 16 ga × 1 NS/LR @ 4–6 mL/kg/h	Expect 100–200 mL blood loss, mostly during cleaning of the wound made while developing a flap.
Control of blood loss	Tourniquet may be used.	Inflation pressure is typically 100 mmHg + systolic pressure. Maximum "safe" tourniquet time is 1.5–2 h, followed by a 5- to- (preferably) 15-min reperfusion interval, if further tourniquet is necessary.
Special considerations	Tourniquet deflation and limb reperfusion	Mild ↓ BP is common. In patients with moderate-to-severe lung disease, continue controlled ventilation until after the lactic acid accumulated in the ischemic leg is metabolized (3–5 min), because these patients may be unable to increase ventilation adequately to buffer this acid load.
Monitoring	Standard monitors (see p. B-1). ± CVP line ± Arterial line	Invasive monitoring is indicated in the presence of severe cardiac or pulmonary disease. Serial blood glucose determination should be made in the diabetic patient.

Positioning	and pad pressure points. eyes.	Meticulous padding of the extremities is necessary to prevent ischemic skin ulceration in patients with vascular insufficiency.

Postoperative

Complications	Hematoma Bleeding	drains.
Pain management	Spinal opiates Epidural analgesia	Epidural hydromorphone 50 mcg/mL infused at 50–200 mcg/h provides excellent analgesia.
Tests	CXR if CVP was placed.	Other studies as indicated.

Suggested Readings

1. Bohne WHO, Ertl JP: Ampuations of the lower extremity. In *Chapman's Orthopaedic Surgery,* Vol 3, 3rd edition. Chapman MW, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 3149–74.

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2. Fung DL: Anesthesia and pain management. In *Chapman's Orthopaedic Surgery,* Vol I, 3rd edition. Chapman MW, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 133–56.

3. McCollough NC III, Epps CH Jr, Banks WJ Jr: Complications of amputation surgery. In *Complications in Orthopaedic Surgery,* 3rd edition. Epps CH Jr, ed. JB Lippincott, Philadelphia: 1994, 1279–1308.

4. Sites BD, Brull R: Ultrasound guidance in peripheral regional anesthesia: philosophy, evidence-based medicine, and techniques. *Curr Opin Anaesthesiol* 2006; 19(6):630–9.

5. Tran D, Clemente A, Finlayson RJ: A review of approaches and techniques for lower extremity nerve blocks. *Can J Anaesth* 2007; 54(11):922–34.

Fasciotomy of the Thigh

Surgical Considerations

Description: Increased intracompartmental pressure in the thigh requires surgical release of tight skin and fascial structures (Fig. 10.6-5). This usually occurs after severe trauma to the thigh (e.g., crush injury, comminuted fracture, etc.), after prolonged vascular surgery (with ischemia to the thigh), or with infection. Compartment syndrome is a true emergency and must be treated within minutes of recognition. Failure to do so may result in loss of limb or death. Conventional devices may be used to measure intracompartmental pressure, which usually is abnormal if > 30–35 mmHg (normal = < 30 mmHg). **Fasciotomy of the thigh** involves incising the skin and fascia over the thigh and debriding any necrotic tissue. The wound is left open for later redebridement, delayed primary closure, or skin grafting. Thus, the fasciotomy begins a multistage procedure of incision and debridement with subsequent reconstruction.

Usual preop diagnosis: Compartment syndrome of thigh; crush injury to thigh; necrotizing fasciitis

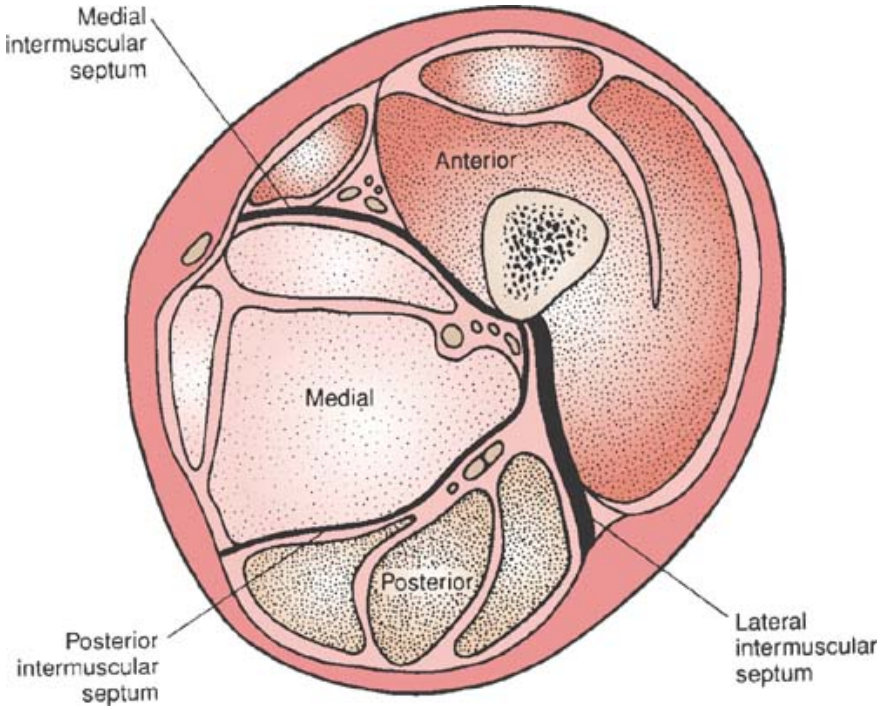

Figure 10.6-5. 5. Cross-section of the thigh showing the 3 major compartments. (Reproduced with permission from Tarlow SD, Achterman C, Hayhurst J, Ovadin D: Acute compartment syndrome of the thigh. *J Bone Joint Surg* [Am] 1986; 68:1441.)

Summary of Procedures

Position	Supine or lateral decubitus
Incision	Lateral thigh
Unique considerations	Patient may be very ill. If an ipsilateral femoral fracture is present with a compartment syndrome, the surgeon may want to perform ORIF, intramedullary nailing, or external fixation of the fracture.
Antibiotics	Cefazolin or cefamandole 1 g iv q 6 h
Surgical time	1.5–2 h for fasciotomy alone
Closing considerations	Wound left open and covered by sterile dressings.
EBL	250–500 mL
Postop care	If surgery is performed acutely, patient frequently will be a multiple-trauma victim with numerous injuries and extensive blood loss; usually goes to ICU.
Mortality	Dependent on extent of multiple trauma
Morbidity	Hypotension and fluid loss: Common Neurological deficit to peripheral nerves: Common, if decompression delayed Respiratory distress and fat embolism: Not uncommon, if concomitant femur fracture Vascular complications: Not uncommon Amputation: Rare, if decompression prompt Systemic sepsis: Rare Wound infection: Rare New compartment syndrome; insufficient fasciotomy: Rare
Pain score	7–8

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Patient Population Characteristics

Age range	Any age, but predominance of males < 30 yr
Male:Female	5:1
Incidence	Extremely rare
Etiology	Trauma—motorcycle and motor vehicle accidents, falls, industrial injury, crush injuries; postsurgery—local hematoma and swelling; thrombosis or disruption of blood supply to thigh (e.g., failed proximal vascular bypass surgery, aortic dissection, etc.); massive infection of thigh compartment (e.g., gas gangrene)
Associated conditions	Burns; drug and alcohol overdose; frequently associated with trauma to other organ systems

Anesthetic Considerations

See Anesthetic Considerations following Fasciotomy of the Leg, p. 1055.

Suggested Readings

1. Dutkowsky JP: Miscellaneous nontraumatic disorders. In *Campbell's Operative Orthopaedics,* Vol 1, 9th edition. Canale ST, ed. Mosby-Year Book, St. Louis: 1998, 787–856.

2. Meyer RS, Mubarak SJ: Compartment syndromes. In *Chapman's Orthopaedic Surgery,* 3rd edition. Chapman MW ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 393–416.

Fasciotomy of the Leg

Surgical Considerations

Description: This procedure is the surgical decompression of fascial compartments for treatment or prevention of compartment syndrome. Patients are often very ill and unstable with other injuries or disease. Compartment *(Print pagebreak 1054)* syndrome is a true emergency and must be treated within minutes of recognition. Failure to do so may result in loss of limb or death. There are four compartments in the leg: anterior, lateral, deep posterior and superficial posterior (Fig. 10.6-6). Generally, all four compartments are released during the procedure. A **four-compartment fascial decompression** can be performed through two incisions—medial and lateral. A medial longitudinal incision is made just posterior to the tibia; through this incision, the superficial and deep posterior compartments are identified and the fascia incised in longitudinal fashion. A straight, lateral, longitudinal incision is made and the deep fascia overlying the anterior and lateral compartments is identified. The fascia of each compartment is then incised longitudinally. Skin incisions are rarely closed because of the swelling. A compression dressing is applied and splints may be used.

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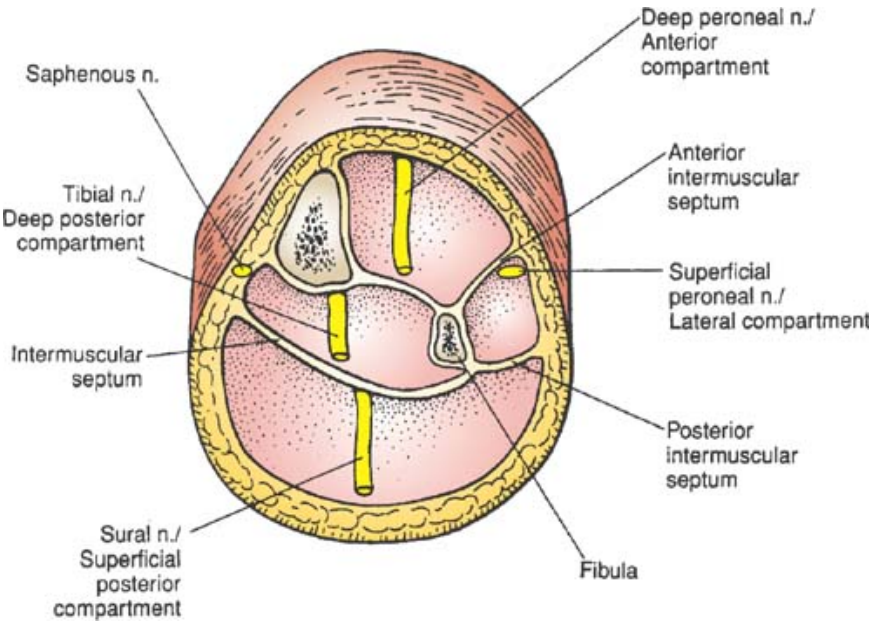

Figure 10.6-6. 6. Cross-section of the left leg, middle lower third, showing the four compartments with associated peripheral nerves. (Reproduced with permission from Mubarak SJ, Owen CA: Double-incision fasciotomy of the leg for decompression in compartment syndromes. *J Bone Joint Surg* [Am] 1977; 59:184–7.)

Usual preop diagnosis: Compartment syndrome; vascular trauma

Summary of Procedures

Position	Supine
Incision	Medial and lateral parallel to tibia
Unique considerations	Often associated with fracture; may require fixation.
Antibiotics	Cefazolin 1 g iv preop
Surgical time	30 min +
Closing considerations	Wounds left open; splint may be required.
EBL	100 mL
Postop care	PACU → room; vascular monitoring is carried out clinically via a pulse oximeter on toes.
Mortality	Minimal
Morbidity	Myonecrosis: 50% Thrombophlebitis: 10–20% Infection: 10–15%
Pain score	3

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Patient Population Characteristics

Age range	All ages
Male:Female	1:1
Incidence	5% of tibia fractures
Etiology	Trauma – blunt fracture, vascular (90%); drug overdose (10%); burns (< 5%); revascularization (< 5%)
Associated conditions	Multiple trauma (60%); vascular disease (15%)

Anesthetic Considerations for Fasciotomy of Thigh and Leg

Preoperative

Compartment syndromes and necrotizing fasciitis are the indications for these procedures (necrotizing fasciitis also may cause compartment syndrome). Patients with compartment syndrome often have no systemic disease, while patients with necrotizing fasciitis have a rapidly life-threatening infection that requires prompt surgical debridement and often is complicated by rhabdomyolysis and DIC.

Respiratory	Usually no special considerations, unless massive sepsis.
Cardiovascular	Sepsis is uniformly present in patients with necrotizing fasciitis. Management includes antibiotics and hemodynamic support with dopamine (5–15 mcg/kg/min) or epinephrine (0.02–0.25 mcg/kg/min), with therapy guided by invasive hemodynamic monitoring, which may include PA catheter.
Neurological	If fasciotomy is for compartment syndrome, there may be compromise of distal nerves and blood flow. Perform a thorough neurologic exam of the involved extremity to document preop deficits.
Hematologic	If infection is the indication for the fasciotomy, DIC is likely. Evaluate for pathologic bleeding. Administer factors necessary to correct coagulopathy during the procedure. **Tests:** CBC; PT; PTT; fibrinogen; fibrin split products; Plt count
Renal	Both necrotizing fasciitis and compartment syndrome often cause myoglobinuria and rhabdomyolysis. Myoglobinuria can be inferred from urine that is dipstick-positive for occult blood but microscopically free of RBCs in the absence of hemolysis (therefore, no free Hb in the urine).
Laboratory	Hct; serial K^+ levels if there is an active diuresis; other studies as indicated from H&P.
Premedication	Standard premedication (see p. B-1).

Intraoperative

Anesthetic technique: Regional techniques are appropriate for compartment syndrome decompression, unless there is evidence of DIC or systemic infection. These surgeries are usually of short duration (< 1 h). Sepsis and hemodynamic instability usually mandate GETA for fasciotomy in patients with necrotizing fasciitis.

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Regional anesthesia: Either subarachnoid or epidural blocks are useful in the absence of systemic infection or severe coagulopathy. Subarachnoid anesthesia has the advantage of adequate blockade of the sacral roots that are resistant to low-dose epidural techniques. Anesthesia from T10-S2 is adequate. Typical drugs and dosages include: subarachnoid—15 mg of 0.5% bupivacaine; epidural—12–15 mL 2% lidocaine with epinephrine 1:200,000 in divided doses.

General anesthesia:

Induction	Standard induction (see p. B-2).
Maintenance	Standard maintenance (see p. B-2).
Emergence	Consider postop ventilation for patients with impaired oxygenation or ongoing hemodynamic instability; otherwise, no special considerations.

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Blood and fluid requirements	IV: 16 ga × 1 (compartment syndrome) 14–16 ga × 2 (necrotizing fasciitis) NS/LR @ 4–6 mL/kg/h	To prevent renal damage, **insure adequate circulatory volume**; induce osmotic diuresis with mannitol 0.25 g/kg iv. Furosemide 10–100 mg also may be necessary to maintain diuresis. Replace UO with 0.5 NS + 50 mEq bicarbonate/L, or as guided by invasive monitoring. Fluid losses (3rd-spacing, bleeding) may be significant.
Monitoring	Standard monitors (see p. B-1). UO ± Arterial line (± ABG) ± CVP or PA catheter	Patients with necrotizing fasciitis require an arterial line and either a CVP or PA catheter to guide fluid and inotropic/pressor therapy.
Positioning		and pad pressure points. eyes.

Postoperative

Complications		DIC Renal failure 2° rhabdomyolysis Hypo/hyperkalemia Sepsis syndrome, including ARDS
Pain management	PCA or epidural analgesia	See p. C-3.
Tests	Hct Electrolytes UA (dipstick and microscopic)	For patients with sepsis: coag profile, including PT/PTT, fibrin split products, and Plt count

Suggested Readings

1. Bucholz RW, Heckman JD, eds: *Rockwood and Green's Fractures in Adults,* 5th edition. Lippincott Williams & Wilkins, Philadelphia: 2001.

2. Epps CH Jr, ed: *Complications in Orthopaedic Surgery,* 3rd edition. JB Lippincott, Philadelphia: 1994.

3. Meyer RS, Mubarak SJ: Compartment syndromes. In *Chapman's Orthopaedic Surgery,* 3rd edition. Chapman MW ed. Lippincott Williams & Wilkins, Philadelphia: 1993, 2001, 393–416.

Biopsy, Leg and Foot

Surgical Considerations

Description: Biopsy is performed to excise tissues for pathologic evaluation, usually through a small, longitudinal wound. For

incisional biopsy, a longitudinal incision is made over the mass. Overlying soft tissues are incised with *(Print pagebreak 1057)* minimal undermining. The area in question is incised and the biopsy removed, with care being taken to prevent spillage into the adjacent tissues. The pathologist often is asked to perform a frozen section to determine whether diagnostic tissue is present. The wound is closed with interrupted sutures and a compression dressing applied. A splint or cast may be used if a significant amount of bone has been removed. If the lesion is small, x-ray control or image intensification may be necessary for localization. **Needle biopsy** may be used for distinct osseous lesions to obtain small amounts of tissue for culture or histology. **Excisional biopsy** may be used for benign lesions like exostoses or lipomas.

Usual preop diagnosis: Tumor; infection

Summary of Procedures

	Incisional Biopsy	Needle Biopsy	Excisional Biopsy
Position	Supine		
Incision	Short longitudinal	Stab wound	Stab wound
Special instrumentation	Bone-cutting instruments; x-ray or I.I.	Trephine (e.g., Craig needle); x-ray or I.I.	X-ray or I.I.
Unique considerations	Tourniquet		(Bone graft may be necessary.)
Antibiotics	None (May be given postop.)		
Surgical time	1 h	0.5 h	0.5–2 h
Closing considerations	May be splinted.	Usually no splint	May be splinted.
EBL	50 mL	Minimal	100–200 mL
Postop care	PACU → room or home		PACU → room
Mortality	Minimal		
Morbidity	Hematoma: 5% Tumor spread: < 5% Infection: < 1%		
Pain score	3	2	3

Patient Population Characteristics

Age range	All ages
Male:Female	1:1
Incidence	Rare
Etiology	Tumor (75%); infection (25%)
Associated conditions	Metastatic disease; immune compromise

Anesthetic Considerations

See Anesthetic Considerations for Lower-Extremity Procedures, p. 1059.

Suggested Reading

1. Enneking WF: *Musculoskeletal Tumor Surgery.* Churchill Livingstone, New York: 1983.

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Biopsy or Drainage of Abscess/ Excision of Tumor

Surgical Considerations

Description: This procedure involves obtaining a piece of tissue for histologic and/or bacteriologic Dx by closed, percutaneous means or by open biopsy. Subsequently, the area may be drained (abscess or infection) or an open excision of a tumor may follow (± internal fixation). For excision of tumors of the pelvis, acetabulum or femur, please consult the appropriate section describing fractures of the area. Each case must be individualized.

Variant procedure or approaches: Excision of infection or tumor of proximal or distal femur, femoral shaft, pelvis, or acetabulum.

Usual preop diagnosis: Femur: biopsy of mass; infection; osteomyelitis. Pelvis or acetabulum: biopsy of pelvis or acetabulum; drainage of abscess or infection of pelvis or acetabulum; osteomyelitis of pelvis or acetabulum; septic arthritis of acetabulum

Summary of Procedures

Position	Supine or lateral decubitus
Incision	Percutaneous, short or long; location depends on site of lesion.
Special instrumentation	Biopsy needles and instruments to take a core biopsy; bone cement may be used to plug biopsy site. Some surgeons use fracture table or radiolucent table with I.I.
Unique considerations	May require intraop frozen section and gram stain.
Antibiotics	After tissue has been obtained, cefazolin or cefamandole 1 g iv q 6 h × 48 h. A gram stain will help decide immediate antibiotic coverage, but cultures and sensitivities are ultimately necessary.
Surgical time	1 h for simple procedures; much longer (up to 12 h) for more extensive excisional procedures ± further reconstruction.
EBL	100–1,000 mL or more
Postop care	If procedure is extensive with much blood loss, or the patient is unstable or ill from chronic sepsis or invasive tumor, it is prudent to send patient to ICU.
Mortality	Dependent on extent of procedure. Biopsy or drainage of a small, localized abscess in soft tissue or bone is rarely life-threatening. Wide/radical excision of a malignant tumor in the pelvis or extremities is frequently life- and/or limb-threatening.
Morbidity	The following are dependent on site and procedure: Intraop fracture Nonunion Chronic osteomyelitis Compartment syndrome Residual instability of pelvis or hip joint Fracture of pelvis or acetabulum, nonunion Chronic osteomyelitis or septic arthritis Hypotension 2° to blood loss Respiratory distress Neurological injury to lumbosacral plexus, sciatic nerve, or other peripheral nerves Vascular injury to iliac or other vessels Injury to GI, genitourinary, or gynecological organs
Pain score	2–10

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Patient Population Characteristics

Age range	Any age; predominance of elderly patients with tumors
Male:Female	1:1
Incidence	Rare
Etiology	Benign and malignant tumors (common); infection (rare); previous surgery (rare); previous trauma (rare)
Associated conditions	Metastatic disease or other foci of infection

Anesthetic Considerations for Lower-Extremity Procedures

(Procedures covered: ORIF of femur, tibia, ankle, and foot; intramedullary nailing of femur and tibia; closed reduction and external fixation of femur and tibia; distal tibia, ankle and foot procedures; repair nonunion/malunion of femur and tibia; ankle arthroscopy, arthrotomy, arthrodesis; repair/reconstruction, ankle ligaments; Syme's amputation; transmetatarsal amputation; tendon (ankle, foot) lengthening; biopsy of leg and foot; biopsy or drainage of abscess/excision of tumor)

Preoperative

Trauma victims comprise the largest group of patients for these procedures. Minimizing the time between fracture and surgery for open wounds significantly reduces the incidence of wound infection. Evaluations for other injury, adequacy of fluid resuscitation and preexisting conditions need to be undertaken promptly and used as a guide for anesthetic management. Patients with bone cancer form another subset of patients and often have concurrent medical conditions and have undergone chemotherapy or radiation therapy preop.

Respiratory	Pulmonary fat embolus occurs in 10–15% of patients following bone fracture. Sx include hypoxemia, ↑ HR, tachypnea, respiratory alkalosis, mental status changes, and conjunctival petechiae. Lab analysis may reveal fat in the urine. Preop therapy for this condition should include supplemental $O_2$with mechanical ventilation, to correct hypoxemia, and meticulous fluid management to prevent worsening pulmonary capillary leak. **Tests:** Consider CXR; others as indicated from H&P.
Cardiovascular	Cardiac contusion or tamponade are possible if blunt chest trauma has occurred during the injury. A large volume of blood can be hidden around a long bone fracture site. ↑ HR, orthostasis, or ↓ BP indicate hypovolemia, and this should be corrected with crystalloid (10–40 mL/kg) or blood if Hct < 24%. In patients with a tibial or distal femur fracture, and who are presenting with hemodynamic instability and ongoing blood loss, consider applying a tourniquet to the thigh prior to induction. **Tests:** Consider ECG; CPK enzyme levels and ECHO will help evaluate the presence of cardiac injury.
Neurological	Perform a thorough neurological evaluation, including mental status and peripheral sensory exams. A CT scan of the head is indicated for any patient with prolonged loss of consciousness prior to anesthesia. Drug abuse is common in trauma patients and they should be asked specifically about any drug use. **Tests:** Patients with inappropriate behavior or a positive drug abuse Hx should undergo a urine and plasma drug screen.
Musculoskeletal	Consider cervical instability and obtain spine films if mechanism of injury included rapid deceleration or trauma to the head or neck. Myoglobinemia and ↑ K^+may result from crush injury. Patients with cancer who have undergone chemotherapy and multiple transfusions often develop sensitivities to blood products

Hematologic	and may require specialized blood products, such as leukocyte-poor PRBC or red cells negative for a particular antigen. The availability of these blood products should be confirmed before surgery. **Tests:** Hct and others as indicated from H&P.
Renal	**Tests:** UA
Laboratory	Other tests as indicated from H&P.
Premedication	Due to the risk of gastric aspiration, minimal or no premedication is given to trauma victims. For other patients, standard premedication (see p. B-1). Narcotic premedication (morphine 1–2 mg iv q 10 min titrated to effect) is appropriate for patients experiencing pain with movement.

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Intraoperative

Anesthetic technique: For trauma patients, regional anesthesia permits evaluation of mental status, provides intact airway reflexes, and ↓ blood loss. Combative patients and those requiring multiple concurrent surgical procedures or prolonged (> 2 h) procedures are often managed with GETA.

Regional anesthesia: Either subarachnoid or epidural blocks are useful techniques. Subarachnoid anesthesia has the advantage of adequate blockade of the sacral roots that are resistant to low-dose epidural techniques. Epidural anesthesia allows for the administration of postop epidural analgesia. Anesthesia from T12 (T8 with tourniquet) to S2 is adequate. Full motor blockade is desirable. Typical drugs and doses include: subarachnoid—15 mg of 0.5% bupivacaine with morphine 0.2 mg (omit if outpatient); epidural—12–15 mL 2% lidocaine with epinephrine 1:200,000 in divided doses (Na bicarbonate 0.1 mg/mL will speed onset of block).

General anesthesia:

Induction		Standard induction (see p. B-2) is appropriate for patients with normal airways. Trauma patients require a rapid-sequence induction (see p. B-5) and intubation with cricoid pressure to prevent gastric aspiration.
Maintenance		Standard maintenance (see p. B-2). Trauma patients are often cold and require active warming if < 35°C (convection blanket and active humidifier). Warming the patient may unmask severe hypovolemia that should be corrected.
Emergence		Trauma patients should have full return of protective airway reflexes and, given the possibility of fat embolus, evidence of adequate oxygenation on 50% O_2 prior to extubation.
Blood and fluid requirements	IV: 14–16 ga × 2 NS/LR @ 4–8 mL/kg/h Warm fluids. Humidify gases.	Some fractures can involve large (30 mL/kg) blood losses that are hidden in the leg or thigh. Clinical signs of hypovolemia and serial Hct determination should guide fluid therapy.
Control of blood loss	Tourniquet	Inflation pressure is typically 100 mmHg + systolic pressure. Maximum “safe” tourniquet time is 1.5–2 h, followed by a 5– to-(preferably) 15-min reperfusion interval, if further tourniquet time is necessary.

Monitoring	Standard monitors (see p. B-1). ± Arterial line ± CVP line	Arterial/CVP lines indicated for patients with ↓BP not readily correctable with crystalloid infusion, massive blood loss (> 1 blood volume), or the need for postop ventilation.
Positioning		and pad pressure points. eyes.
Special considerations	Release of tourniquet	A 20% ↓MAP is common on tourniquet deflation. Additional crystalloid (5–10 mL/kg) may be necessary to replace edema fluid and blood loss to the leg.
Complications	Fat embolism Myoglobinemia	

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Postoperative

Complications	Hypoxemia VTE (DVT)	May be 2° fat embolism. see VTE prophylaxis guidelines p. B-7
Pain management	Spinal opiates: Epidural anesthesia Spinal anesthesia	Epidural hydromorphone 50 mcg/mL infused at 100–250 mcg/h provides excellent analgesia. Intrathecal morphine 0.2–0.3 mg provides analgesia for up to 24 h after administration. (Monitor for delayed respiratory depression.)
Tests	Hct CXR, if CVP placed or oxygenation is impaired.	Other studies as indicated.

Suggested Readings

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4. Tran D, Clemente A, Finlayson RJ: A review of approaches and techniques for lower extremity nerve blocks. *Can J Anaesth* 2007; 54(11):922–34.

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