Extremity Compartment Syndrome

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Algorithmic Approach

A. In the setting of extremity trauma, acute extremity compartment syndrome should be considered after the patient has been otherwise evaluated and stabilized. Extremity compartment syndrome can develop after blunt or penetrating injury, with or without fractures [1]. Up to 75% of extremity compartment syndrome is due to tibia fractures, with the incidence of extremity compartment syndrome in tibia fractures reported from 1% to 10% [2]. Vascular injuries should be identified promptly, as they can be associated with compartment syndrome due to lack of arterial inflow, lack of venous outflow, or both [3]. Other patients at significant risk for extremity compartment syndrome are those with a significant crush injury or motor vehicle collision with entrapment. Recreational use of injection drugs, infiltrated IV sites, burns, and prolonged compression due to poor OR positioning are other risk factors, as is acute arterial ischemia due to peripheral vascular disease [2]. The diagnosis of extremity compartment syndrome is nebulous and requires a high index of suspicion; the consequences of delay to diagnosis or delay to treatment are severe and include loss of function, loss of limb, and renal failure if rhabdomyolysis accompanies the compartment syndrome [4]. It is suggested that functional impairment of muscle becomes permanent after 4–12 h, and nerve damage becomes irreversible after 12–24 h [5].

B. In addition to obtaining the details of the inciting event, key symptoms of extremity compartment syndrome to elicit are pain out of proportion to exam; a persistent, deep, aching pain or burning pain; and paresthesias. These symptoms may indicate ischemic changes of the muscles and nerves. The "6 Ps" of arterial ischemia (pain, pallor, pulselessness, paresthesia, pressure, poikilothermia) are associated with, but not diagnostic of, extremity compartment syndrome. When present, they have a high specificity, but the sensitivity is lacking [5]. Pain, particularly pain out of proportion to exam or to apparent injury, is the most common and consistent finding [2].

C. The physical exam should consist of gross examination of the extremity observing for pallor or mottling. Pain with palpation and with passive stretch should be evaluated. A

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full neuromuscular exam should be performed, noting strength and sensation in all the affected muscle groups and dermatomes. Make note of the size of the extremity. Circumferential measurements of the affected and contralateral extremity should be obtained when able. Tense, tight extremities, with shiny-appearing skin and a woody feeling on palpation, have a high likelihood of extremity compartment syndrome. Distal pulses should be palpated or Doppler signals obtained. Pulselessness is uncommon in extremity compartment syndrome as it requires the extremity pressure to exceed the arterial blood pressure but can occur given the right combination of a hypotensive patient, severe compartment syndrome, and/or a vascular arterial injury [4]. If the patient is awake, alert, and able to be examined, serial examinations should be performed every hour as compartment syndrome progresses rapidly. Sedated or obtunded patients who cannot undergo serial exams should undergo evaluation of compartment pressures [4] with consideration given for prophylactic or empiric fasciotomy if suspicion is high for extremity compartment syndrome.

D. There are a few accepted methods of measuring compartment pressures. The simplest and most common is a pressure monitoring needle, such as the one made by Stryker. Other methods include transducing the pressure using a needle and arterial line setup and the slit catheter technique [4]. Compartment pressures vary depending on the compartment, and even vary within a single compartment, necessitating multiple measurements in multiple areas [5].

E. There is no agreed-upon value for diagnosis of extremity compartment syndrome. Commonly used values are compartment pressure of >/=30 mmHg or delta pressure of </=30 mmHg [6]. (Delta pressure is the difference between the diastolic pressure and the compartment pressure.)

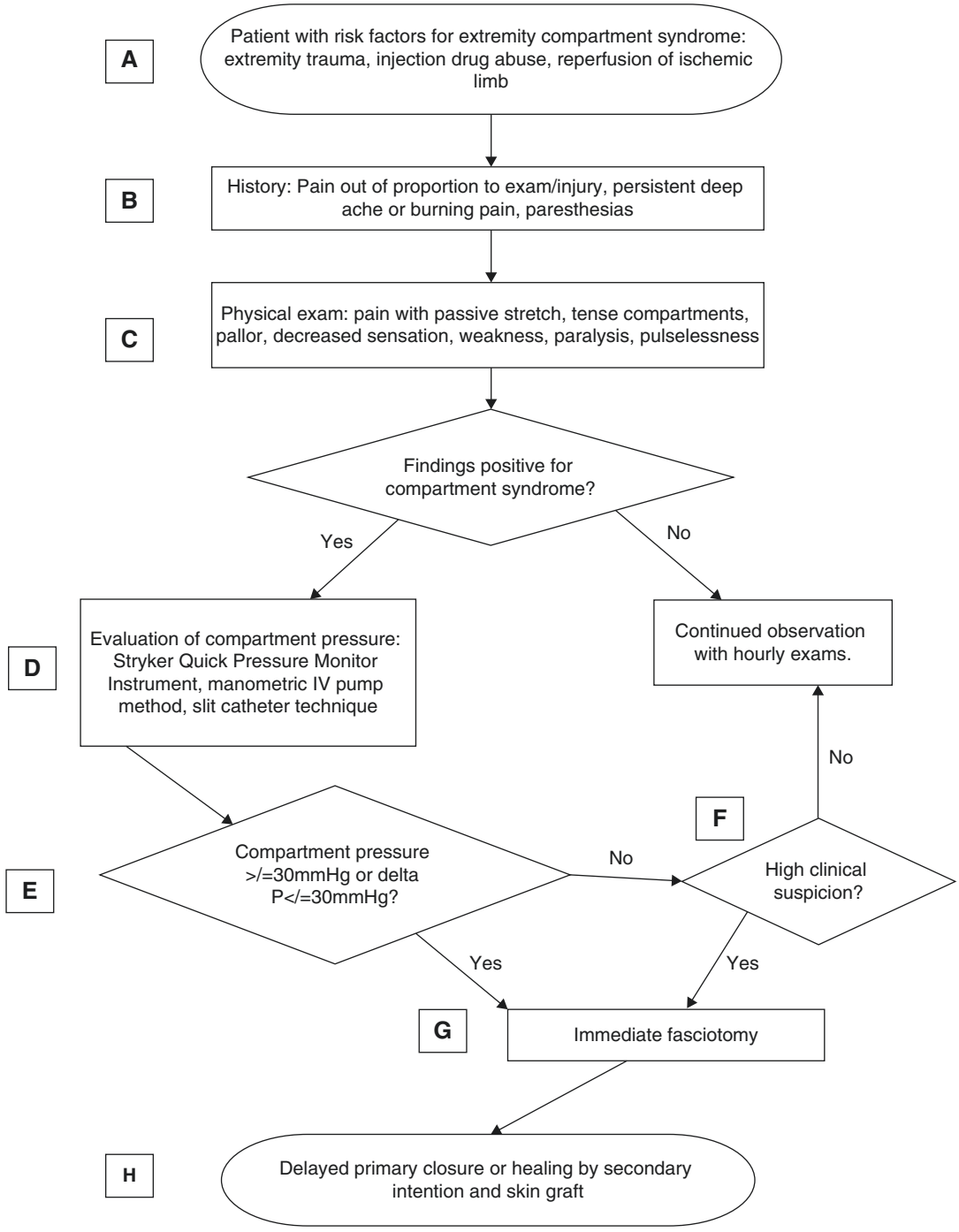
F. Clinical suspicion must be high, and the diagnosis must be made with a combination of physical exam findings and compartment pressures. A patient with risk factors and progressive signs and symptoms of pain, paresthesias, and decreased sensation or motor function has sufficient indications for fasciotomy. Fasciotomy should not be delayed while awaiting the Stryker needle to reach the designated reading [6]. There is no consensus as to the specific indications for fasciotomy, and the diagnosis of extremity compartment syndrome is “capricious and elusive” [6].

G. Emergent fasciotomy as soon as the diagnosis has been made is the mainstay of treatment for extremity compartment syndrome. Adjunct maneuvers to improve flow include relieving any external forces causing increased compartment pressure such as dressings, splints, or casts. Reduction of fractures or dislocations can often restore blood flow to the affected extremity. The limb should remain in neutral position so as to avoid changes in blood flow that can either increase vascular congestion or cause further reduction in arterial blood flow. If the patient is noted to be hypotensive, resuscitation with either crystalloid or colloid should be implemented to avoid hypoperfusion and further tissue injury [4]. Fasciotomy should be performed promptly to prevent permanent damage. Although there is evidence to support that irreversible muscle damage begins as early as 4 h after onset of ischemia, the generally accepted timeframe is 6 h to fasciotomy to preserve muscle [4–6].

The key to fasciotomy is complete release of all involved compartments. There are two procedures that will allow for release of compartments. There are four compartments in the leg: anterior, lateral, superficial posterior, and deep posterior. These are most commonly released via two incisions (medial and lateral). The anterior and lateral compartments are released via the lateral incision, and the superficial and deep posterior compartments are released through the medial incision. The anterior compartment of the leg is the most common site of extremity compartment syndrome [2].

In the thigh there are three compartments: anterior, posterior, and medial. Typically extremity compartment syndrome in the thigh can be managed with a long lateral incision to release the anterior and posterior compartments, as compartment syndrome in the medial adductors is rare [4]. The forearm has four compartments: deep volar, superficial volar, dorsal compartment, and lateral compartment [2]. Fasciotomy is performed through volar and dorsal incisions, with access to the lateral compartment (aka the "mobile wad") via the dorsal incision [1]. There are only the anterior and posterior components which must be released in the arm [2]. This is accomplished with a lateral incision and release of the fascial planes of the biceps brachii and triceps brachii.

H. Wound closure should not be attempted prior to resolution of tissue edema, due to the inherent risk of repeat tissue ischemia [4]. Patients should return to the operating room (OR) for attempted closure on postoperative days 3–5. Delayed primary closure is preferred, but if necrosis persists, further debridement should be undertaken prior to closure. Similarly, if tissue edema remains too high to allow skin coverage, the wounds should be allowed to heal via secondary intention. Once an adequate bed of granulation tissue has formed, a split-thickness skin graft should be used for coverage [4].



Algorithm 169.1

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