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Vascular Assessment of the Foot Surgery Patient

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Foot surgery is common. Orthopaedic nurses charged with evaluating and treating patients who have undergone foot surgery are required to evaluate the vascular status of the patient's foot (or feet). As a result, these nurses are often the first to identify vascular issues. This article provides orthopaedic nurses with the background to understand how the patient's history, the procedure(s) performed, and a thorough assessment of the foot's circulation will allow them to promptly identify circulatory problems and potentially save a patient from having a serious complication.

Introduction

Foot problems are common in our society. A survey conducted by the American Podiatric Medical Association (APMA) found that 77% of Americans have experienced at least one foot problem and 51% of Americans have had their activities restricted by foot pain (APMA, 2014). The aging population and rise in chronic diseases, such as diabetes, obesity, osteoarthritis, peripheral vascular disease, and others, suggest that orthopaedic nurses working in hospital and outpatient settings will likely experience the pre- and postoperative care of patients with foot and ankle ailments.

Nurses who are charged with evaluating and treating patients who have undergone foot surgery are required to evaluate the vascular status of the patient's foot (or feet). As a result, these nurses are often the first to identify vascular issues. The prompt recognition of a vascular problem may allow for urgent interventions and avoid extreme circulatory complications such as irreversible ischemic injury, gangrene, or the need for an amputation.

Vasculature of the Foot

The human foot and toes are the most distant anatomical structure from the heart. There are two main arteries providing circulation to the foot: the posterior tibial and dorsalis pedis (see Figures 1 and 2). Vascular pulses are typically inspected with the index and the middle finger, with personal protective equipment (see Figures 3 and 4). Nurses should be aware of this anatomy while being cognizant that variation in the vasculature anatomy supplying the foot has been documented. In some cases, either the posterior tibial or dorsalis pedis may be hypoplastic or aplastic, causing this artery to be noncontributory to the foot's circulation (Kil & Jung, 2009). The dorsalis pedis and posterior tibial arteries in the foot lead to arterioles, which then supply capillaries, the smallest blood vessels. The venous vessels typically correspond with an artery and return blood to the heart.

Patient History

When assessing circulation in the foot, nurses should review the patient's history, as it can give insight into potential abnormalities and variations during the physical examination. Patients may relate the classic signs of peripheral vascular disease referred to as intermittent claudication. With this condition, a patient experiences cramping leg pain that happens after walking but dissipates with rest (Watson, Ellis, & Leng, 2008). However, research shows that many patients present with other types of circulation disease while remaining asymptomatic or without experiencing pain (Criqui et al., 1996; Hirsch et al., 2001; McDermott, Mehta, & Greenland, 1999). For example, peripheral vascular disease has been shown to be highly prevalent in primary care practices but remains undiagnosed by clinicians due to patients lacking clinical symptoms.

Because of the higher potential for patients to be pain free, comorbidities that increase the risk for peripheral vascular disease need to be reviewed and acknowledged. Circulation compromise may be greater in elderly persons and those with systemic diseases such as hypertension, diabetes, cardiac issues, high cholesterol, obesity, blood disorders, and anemia (Olive, DeVan, & McCully, 2002). Many systemic diseases can contribute to arteriosclerosis or hardening of the arteries. Diabetes mellitus is an epidemic that accelerates arteriosclerosis by slowing blood flow and increasing inflammation in the vessels and tissues. Hyperlipidemia can cause a buildup of plaque in the arteries, which can

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FIGURE 1. An indication of the dorsalis pedis pulse found on the dorsum of the foot. The "X" indicates where the pulse can be felt with the index and middle finger of the examiner.

cause blockage in the vessels and distal ischemic injury. These diseases are the most commonly seen culprits of vascular disease, but do not encompass every possibility. Hypotension can also reduce blood flow to the feet. A patient's habits, such as a lack of exercise, tobacco use, or marijuana use, can also impair lower extremity circulation (Thomas, Kloner, & Rezkalla, 2014; Taimur et al., 2017).

Finally, nurses should consider inquiring about a patient's prior foot problems and treatment, which may

FIGURE 2. An indication of the posterior tibial pulse found on the medial aspect of the ankle. The "X" indicates where the pulse can be felt with the index and middle finger of the examiner.

FIGURE 3. The dorsalis pedis pulse being examined by a practitioner.

reveal poor circulation. Such issues include a history of an amputation due to ischemic injury, ulceration, or infection. A thorough review of the patient's history will help nurses investigate possible systemic factors that can lead to vascular injury and disease.

The Preoperative Foot

A general visual inspection of the skin and nails of the foot may suggest poor circulation. These findings may include reduced hair growth or atrophic, discolored, or shiny skin (Hennion & Siano, 2013). There may be dry, cracked skin (reduced moisture) or thickened but brittle toe nails (Frykberg et al., 2006). The color of the skin may appear dusky, dark, or even cyanotic in severe peripheral disease.

When evaluating circulation of the foot, both feet should be compared, specifically in regard to palpating the dorsalis pedis and posterior tibial pulses. These pulses should be documented on a scale of 0–4, with 0 being absent and 4 bounding. A healthy pulse is graded 2 out of 4. A lack of equality between the right foot and the left foot may alert the nurse to a problem on the weaker side (Johnston-Walker & Hardcastle, 2011; Wiseman & Curtis, 2011). In addition to assessing the foot's main pulses, the popliteal pulse felt behind the knee may be examined. The popliteal pulse is especially

FIGURE 4. The posterior tibial pulse being examined by a practitioner.

important if the dorsalis pedis or posterior tibial pulses are nonpalpable or abnormal in comparison with the contralateral foot.

The temperature of the foot can be evaluated and is considered an indication of the circulation to the skin. This evaluation can be done by using an infrared thermometer or simply the back of the hand and starting at the ankle and moving to the toes. If the temperature becomes cool, the location of temperature change may reveal where a vascular blockage may be present. A temperature discrepancy with the contralateral foot should alert the nurse to a possible vascular problem.

Next, the nurse should examine the capillary refill time, which is done by pressing down on the nails or tips of the toes and then releasing. The toe or nail bed should "pink up" or show reperfusion in 3 seconds or less (Johnston-Walker & Hardcastle, 2011; Wiseman & Curtis, 2011). While testing the capillary refill time, the nurse should consider the temperature of the toe being examined, which should be warm. All five toes should be evaluated and the capillary refill time should be compared with the contralateral foot, like the pulse assessment. The findings should be documented, taking care to be certain to note that all 10 toes were evaluated. Literature has found that some physical findings, particularly a normal capillary refill time, foot discoloration, lack of hair on the foot and atrophic skin, may be misleading in determining vascular impairment. Many factors of a person's medical comorbidities and history can cause some of these signs without the etiology being vascular impairment. For example, very firm pressure by the nurse assessing capillary refill time may cause blood to return from nearby veins leading to a refill time of less than 3 seconds and the incorrect conclusion of an intact vascular status (McGee & Boyko, 1998). This illustrates the importance of using the history and physical examination to create a complete picture of the patient to determine vascular status.

The Postoperative Foot

While the surgeon or physician will typically examine the foot preoperatively as part of surgical assessment and planning, nurses are often tasked with inspecting the foot postoperatively in conjunction with the surgeon's evaluation. Assessing circulation of the patient's foot in the immediate postoperative period may present unique challenges. The patient will typically have a surgical dressing on the foot or entire lower extremity. The patient may be in a splint or cast, limiting access to the foot. Because of the postoperative foot being in a splint, cast, bandage, or a combination of the three, palpation or comparison of the pulses may not be possible. It is also possible to have surgical hardware exposed after certain surgical procedures, such as a hammertoe correction (see Figure 5). If this is the case, a visual inspection or examination of the small area of exposed foot may be all that is possible at this time. In such cases, the nurse may need to gently nudge the bandage up, down, or to one side to see all the toes. Abnormal findings such as a dusky or blue toe, a toe that is cool or outright cold, or a toe that is slow to pink up during the capillary refill time evaluation (<3 seconds), should alert the nurse to a possible circulation issue.

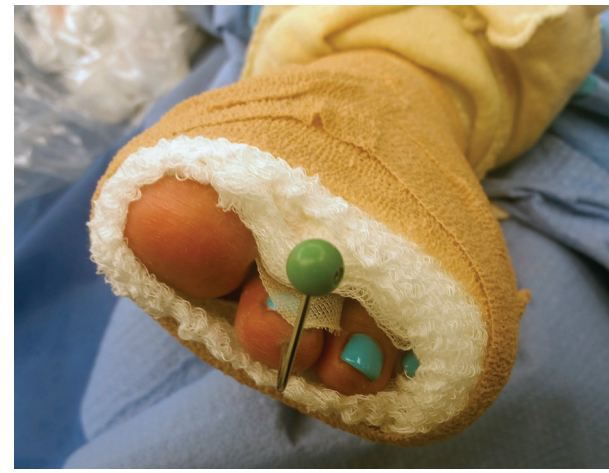

Figure 5. A foot postoperatively showing intact surgical bandaging, exposed surgical hardware (K-wire), and a limited area to examine the vascular status of the foot. The distal aspects of toes 1–4 are noted to be pink in color. However, note that the fifth digit is covered by the surgical bandaging. In this situation, a nurse would need to nudge the bandaging to examine the fifth digit appropriately. The color version of this figure is available in the online issue at https://journals.lww.com/orthopaedicnursing.

Immediate interventions for blue or dusky toes with slow capillary refill time may include dangling the patient's extremity to cause the toe or toes to "pink up." This maneuver may actually cause dependent rubor to happen wherein the toes become purple–red or bright red. Checking the capillary refill time may give the nurse a false indication that circulation is adequate. Furthermore, pooling of blood from the veins may falsely suggest adequate perfusion. To ensure circulation to the toes is intact, the extremity should be elevated to allow any pooled blood to seep away (Halloran, Blume, Palladino, & Sumpio, 2007). Should the toe or toes remain red or pink, the circulation is likely adequate. However, if a toe becomes pale, there may be a vascular impairment. In such situations, further investigation by the nurse is warranted and the nurse should inform the surgeon of the vascularity concern.

The nurse may further investigate suspected impaired circulation by removing the bandage or splint to assess the pedal pulses, skin color, and temperature of the entire foot. The findings should be compared with the other foot. Bandages around the foot that are applied too tightly or that inadvertently become too tight due to postoperative swelling can also become a tourniquet and impair circulation. In such cases, the bandage may need to be loosened or removed with the surgeon's approval. An examination of the extremity using a Doppler machine or a pulse oximeter may be of assistance. Anesthesia teams may also be able to administer local anesthetic to induce a vasodilating effect.

Finally, it is also important to look for signs and symptoms of vascular disease that may have been seen in the "Preoperative Foot" section of this article. Like

the preoperative assessment, this includes reduced hair growth or atrophic, discolored, shiny, or dry skin and brittle nails. Differences in pulse strength, temperature, and capillary refill time should be examined as part of the postoperative vascularity examination. All examination factors should be considered when determining whether a patient has potential vascular compromise after surgical intervention.

Special Considerations

The orthopaedic nurse receiving the postoperative foot surgery patient should consider the procedure(s) performed. Some procedures may increase the risk of circulatory impairment. For example, surgical procedures on the toes may utilize pins or K-wires to provide stability, such as those used to correct hammertoe. A K-wire is a rigid pin that protrudes from the end of the toe, often with a cap at the end (see Figure 5). The use of a K-wire may cause the toe to spasm, decreasing blood flow to the tip of the toe and potentially causing ischemia of the toe. Furthermore, K-wires (and other pins) obscure the tip of the toe, requiring the nurse to take extra care to ensure the circulation is intact.

The use of ice on the foot, which is often ordered postoperatively, can also cause vasospasm and potentially result in circulation impairment. The nurse should be cognizant of the importance of this risk and apply ice intermittently. When a cold therapy machine is used to cool the foot, ankle, or leg postoperatively, the nurse should be vigilant to follow the machine's instructions for use carefully to avoid overuse, which can result in injury. In one case, such a device caused a nonfreezing cold injury to the leg of a 15-year-old girl, necessitating skin grafting and ultimately leaving her with nerve damage and scarring (Bal & Brenner, 2013).

As noted previously, a drop in blood pressure can reduce blood flow to the foot. Serious medical issues, such as extreme blood loss during surgery, pain medication, or effects of anesthesia, may cause a hypotensive episode that requires emergency measures. If this occurs, the patient needs to be stabilized immediately. However, once the patient is stabilized, it is important for the nurse to assess the foot's vascular status to prevent loss of the limb from ischemic injury.

Finally, medical professions must consider the legal implications of their actions and documentation. Most medical governing procedures and documentation aim to not only protect patients and allow for continuity of care, but can also be used in malpractice, compensation, or welfare cases. For these reasons, medical documentation is of increasing importance in this field. Once patients leave the medical facility, they may inadvertently cause the circulation to the foot to become impaired or experience a medical issue that may occlude the vascular supply, such as an embolus. In such situations, the orthopaedic nurse may be asked about whether the vascularity to the foot was adequate when the patient was discharged from the facility. Given this potential inquiry and in keeping with high nursing standards, adequate documentation in the medical record is a critical requirement of nurses. These medical records can be a vital component when a patient seeks review of Social Security disability insurance benefits, supplemental security income benefits, employment benefits, health insurance, and in personal injury litigation (Ford, Carroll, Smith, Scott, & Cassell, 2016).

Summary

Foot surgery is common, and an orthopaedic nurse may be the first person to identify a vascular impairment to a patient's foot after a foot procedure. Understanding the patient's history and the procedure(s) performed and thoroughly assessing the foot's circulation are imperative in identifying circulatory problems and potentially saving a patient from developing a serious complication.

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