Introduction to Incision Technology
Every infant born in the United States and many other countries must undergo at least one heelstick procedure to obtain a blood sample for metabolic screening tests required by law. Some infants, primarily premature or sick babies, undergo a considerably larger number of heelsticks during their hospital stay. In fact, some may be subjected to as many as eight heelstick procedures per day to facilitate various diagnostic tests.

The task of blood sampling from the infant’s heel can often be an unpleasant experience for both the infant and the person drawing the sample. For the infant, pain and bruising may result from this procedure. Additionally, a case of osteomyelitis from the calcaneus could result from a puncture that is too deep or is not performed in the “safe” area. Another problem associated with heel blood sampling includes prolonged healing of the site which can lead to local or systemic infections. This problem can be further compounded if subsequent blood samples cannot be obtained due to prolonged healing of the bruised heel.

For the person drawing the heel blood sample, the procedure is difficult, especially if the desired blood volume cannot be obtained with the first stick. Confronted with a crying infant in pain, and the necessity to stick the infant for a second or sometimes third time, it is not surprising that the task of infant heel blood sampling is dreaded by technicians, nurses, and physicians.

Another universal problem associated with heelsticks is the risk of accidental sticks, which increase the potential for transmission of bloodborne diseases such as hepatitis B or HIV. Conventional heelstick devices that do not feature a retracting blade do not optimize safety. Furthermore, the poor design of many devices and the limited blood flow they provide necessitate a higher frequency of repeat sticks, putting the healthcare worker at an even greater risk for exposure to blood and contaminated sharps.

The Tenderfoot® family of heel incision devices has changed the manner in which heel blood samples are obtained. Tenderfoot offers a safe, effective and painless means of obtaining a heel blood sample from infants and toddlers, greatly reducing clinical complications often associated with conventional heelstick devices. Tenderfoot is available for full term infants, for premature, sick or low birth-weight infants (called Tenderfoot Micro-preemie and Tenderfoot Preemie), and for older infants and toddlers (called Tenderfoot Toddler). Each device incises to a length and depth appropriate for the underlying vasculature of each patient group.

The Tenderfoot device for full term infants makes a standardized incision 2.5 mm in length and 1.0 mm in depth. Because optimal blood flow is achieved using this device, Tenderfoot is extremely effective for obtaining moderate blood sample volumes for metabolic screening tests and other tests such as glucose, CBC, and hematocrit. It has been reported that up to 3 ml of blood can be collected from a Tenderfoot heel incision. The Tenderfoot Micro-preemie device incises to a shallow depth of only .65 mm and 1.40 mm in length. The Tenderfoot Preemie device incises to a shallow depth of 0.85 mm and 1.75 mm in length, which is approximately 40% smaller than the incision made by the original Tenderfoot. The Tenderfoot Toddler incises to a standardized depth of 2.0 mm and a length of 3.0 mm and is an alternative to venipuncture or fingerstick when a moderate blood sample volume is required for tests such as CBC, cholesterol, or blood lead levels.

Unlike lancet devices, the problem of accidental sticks is eliminated when Tenderfoot is used to perform a heelstick. Each Tenderfoot device features a permanently retracting blade that protects the operator and the patient against accidental sticks from an exposed blade contaminated with blood.
ANATOMY

Stress-Strain Characteristics of the Skin
Human skin has unique stress-strain characteristics that can result in skin indentation and compression from even minor pressure. Therefore, undue pressure from a heelstick device when placed against the skin will cause the skin cells to elongate and compress in a distinct, stratified manner. The degree of this indentation can significantly increase the depth of any wound. For example, a lancet device that punctures to 2.4 mm in depth can result in a puncture depth of 3.0 mm - 4.0 mm when the skin is compressed.

Tenderfoot devices differ from lancets in that they feature a flat blade-slot surface; it helps to reduce skin indentation, better controlling and standardizing the incision depth. Because Tenderfoot devices are available in four different sizes, the incision depth is customized to the appropriate age and weight group. As a result, the shallowest possible incision is made.

Vascular Bed*
The vascular bed, which lies 0.35 mm to 0.82 mm below the epidermis is rich in capillary loops. Tenderfoot incises across these capillary loops, yielding optimum blood flow for sampling. Further, the incision provided by Tenderfoot is safe and effective because it is shallower than a puncture eliminating potential injury to the calcaneus. While the Tenderfoot incision may look different from a traditional heelstick puncture, it is actually less invasive.

Pain Fibers*
The pain fibers increase in abundance below 2.4 mm. Several lancets puncture to this depth, or even beyond. Alternatively, the incision made with the Tenderfoot device is well above the concentrated pain fibers. As a result, the infant does not experience the pain associated with traditional puncture devices. The standardized, safe incision depth coupled with the rapid blade action make Tenderfoot heel incisions virtually painless.

Vascular Bed
Rich in capillary loops from 0.35 mm to 0.82 mm in depth. The 1.0 mm incision depth provided by Tenderfoot is safe, effective, and virtually pain-free.

Pain Fibers
Pain fibers increase in abundance below 2.4 mm. Several lancets puncture to this depth (or beyond).
Infant heel blood sampling can result in serious clinical complications if an inappropriate sampling site is selected. Care must be taken to choose the proper heel sampling site to minimize injury to the baby and ensure that a bruised or infected area is not utilized.

The “safe” area to inflict a neonatal or infant heel wound is, “Marked by a line extending posteriorly from a point between the 4th and 5th toes and running parallel to the lateral aspect of the heel, and a line extending posteriorly from the middle of the great toe running parallel to the medial aspect of the heel.” *

As you can imagine, this safe area is quite small. The safe area of a premature or low birth weight infant is even smaller than that of a full term infant. Therefore, it is even more challenging and critical to use only the safe area on the heels of these infants.

Since blood flows freely from the Tenderfoot incision, squeezing the foot is minimized. The result is a dramatic reduction in the incidence of bruising with Tenderfoot, as well as improved healing. Conventional lancets operate on a puncture principle, crushing downward into the vasculature. This action forces dermal and venous debris into the wound, which can lead to a hemolyzed blood sample. Additionally, the blood flow from a puncture wound is often limited, causing the person drawing the blood sample to squeeze the foot to stimulate the blood flow. This squeezing can further contaminate the blood sample, potentially leading to a rejected specimen that is unsuitable for testing. Lancets also lack features to adequately control the puncture depth, which could lead to heel or bone injury.

Regardless of which Tenderfoot device is used, this unique incision making technology provides optimal blood flow without squeezing or “milking” the foot. When the device is triggered, a surgical steel blade protracts down, sweeps across the vasculature of the infant’s heel, and permanently retracts back into the device. Since squeezing is minimized, the infant does not suffer bruising or trauma to the heel. And because the blade incises only in the uppermost vasculature of the heel, pain to the baby is minimized.

The following procedure specifies the proper infant heel blood sampling protocol for using the Tenderfoot heel incision device.

1. Preferably, the baby should be in a supine position with the knee at the open end of a bassinet. This position allows for the foot to hang lower than the torso, improving blood flow. When the baby is in an acceptable position for this procedure, clean the incision area of the heel with an antiseptic swab. Allow the heel to air dry. Do not touch the incision site or allow the heel to come into contact with any non-sterile item or surface. (See figure 1)

NOTE: When Tenderfoot toddler is used on older infants and toddlers, it may be preferable to let the child sit up when performing the heel incision procedure.

2. Remove the appropriate Tenderfoot device from its sterile blister pack, taking care not to rest the blade-slot end on any non-sterile surface. Remove the safety clip. Once the clip is removed, DO NOT push the trigger or touch the blade slot. (See figure 2)

NOTE: The safety clip may be replaced if the test is momentarily delayed; however, prolonged exposure of any Tenderfoot device to uncontrolled environmental conditions prior to use may affect its sterility.

3. Raise the foot above the baby's heart level and carefully select a safe incision site (avoid any edematous or infected area or any site within 2.0 mm of a prior wound). Place the blade-slot surface of the device flush against the heel so that its center point is vertically aligned with the desired incision site. Ensure that both ends of the device are in contact with the skin, and depress the trigger. (See figure 3)
4. After triggering, immediately remove the device from the infant’s heel. Lower the infant’s heel to a position level with or below the baby. Using only a dry sterile gauze pad, gently wipe away the first droplet of blood that appears at the incision site. (See figure 4)

5. Taking care not to make direct wound contact with the filter paper, collection container or capillary tube, fill to the desired specimen volume. Following blood collection, gently press a dry sterile gauze pad to the incision site until bleeding has ceased. This step will help prevent a hematoma from forming. (See figure 5)

NOTE: Bandaging the baby’s foot is a controversial issue because of skin sensitivity and potential bandage aspiration. However, the incision should be noted by the primary care nurse to ensure that the heel can be monitored for bleeding and inflammation.
SUGGESTED READING


Daly CH: Mechanical considerations of bleeding time skin incisions, ITC, 1988.


Young T, Mathews D: A phlebotomy staff's experience with the tenderfoot® neonatal heel incision device. ITC, 1992.
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>CATALOG NUMBER</th>
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<th>LENGTH</th>
<th>CASE COLOR</th>
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*These are suggested indications, ultimately the clinical judgement of the medical staff should determine which Tenderfoot device to use.

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