

Matrix Biopsy of Longitudinal Melanonychia and Longitudinal Erythronychia: A Step-by-Step Approach

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Longitudinal melanonychia and longitudinal erythronychia are presentations that may indicate underlying malignancy. Biopsy is commonly required. This manuscript provides an overview to approaching these problems, a guide to surgery including several biopsy techniques, and tips to ensure adequate tissue sampling while minimizing postoperative complications.

Diagnosis and management of nail disease, including nail surgery, are fundamental to dermatology. Yet, despite widespread ease and comfort with the practice of cutaneous surgery, many dermatologists approach nail surgery with uncertainty. This may stem from their own limited experience in training coupled with patients' fear and anxiety over these procedures. Nail surgery carries the highest risk when performed in the matrix, where postoperative scarring can cause permanent nail splitting, dystrophy, or both.¹ This article reviews the various techniques used to biopsy the nail matrix. The following procedures are similar to those routinely used to biopsy the skin: the punch, the shave, and the fusiform excision (Figure 1). The authors present what they have found to be the most fundamental, safe, reproducible, and effective techniques for obtaining tissue from the nail matrix. The following techniques are discussed in the setting of 2 nail presentations where, in many cases, it is mandatory to obtain a tissue diagnosis:

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longitudinal melanonychia (to diagnose nail melanoma and in some cases squamous cell carcinoma) and longitudinal erythronychia (to diagnose squamous cell carcinoma and, rarely, amelanotic melanoma and basal cell carcinoma).

LONGITUDINAL MELANONYCHIA

Longitudinal melanonychia is defined as longitudinal brown or black pigmentation of the nail. The differential diagnosis of longitudinal melanonychia is broad, including blood, exogenous pigments, bacterial pigment, mycotic pigment, and melanin.² Melanocytes in the matrix can be activated without a proliferation, producing increased pigment that results in a brown or black band in the plate. This can be likened to normal skin, where this phenomenon is triggered by UV light and called a *freckle*. However, melanocytes in the matrix can be increased in number and activity as single cells resulting in a lentigo or nested as a nevus. As with other lentigines and nevi on the skin, the melanocytes can display atypical or even malignant features, resulting in the diagnosis of atypical nevus or melanoma of the nail.

The clinical distinction among the various entities in the differential diagnosis of longitudinal melanonychia can be difficult for even the most experienced clinician. Although a thorough history and physical examination including dermatoscopy are performed in each case, in many instances a biopsy of the matrix at the origin of the band is necessary to make the diagnosis.²⁻⁵

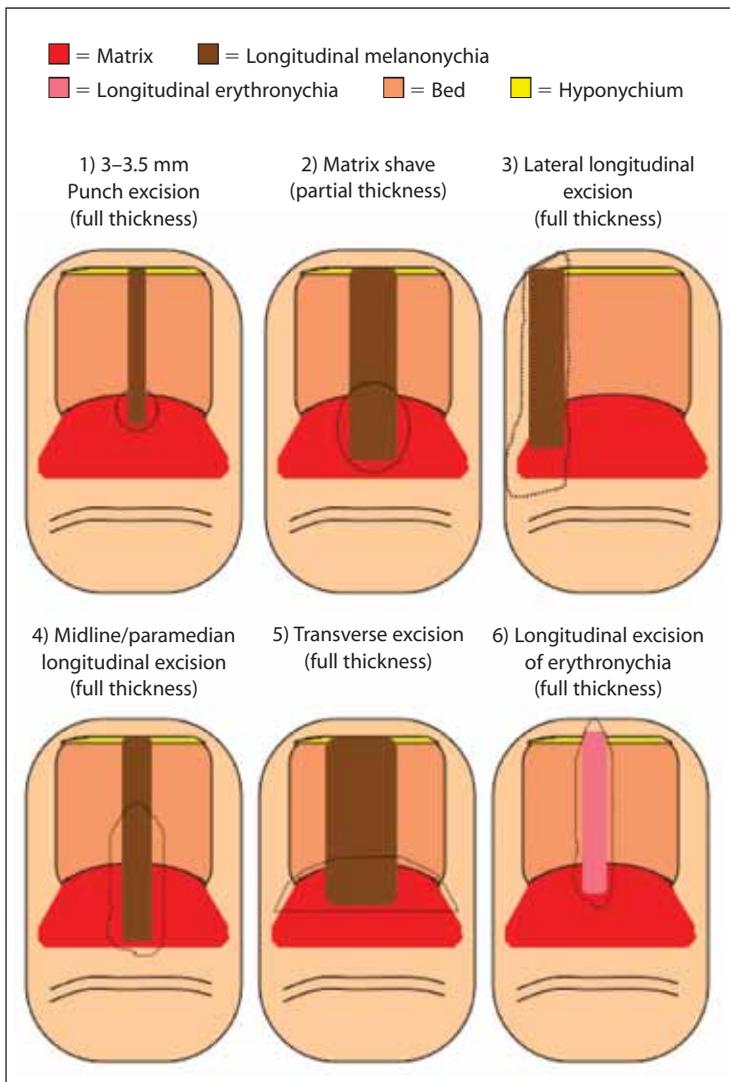


Figure 1. Techniques used to biopsy the nail matrix.

Dermoscopy is helpful in locating the origin of longitudinal melanonychia in the matrix.⁶ The proximal matrix is responsible for making the dorsal 80% of the nail plate. The distal portion of the matrix is responsible for making the ventral 20% of the nail plate. Dermoscopy of the free edge of the nail plate can identify pigment originating in the proximal matrix projecting onto the dorsal plate and pigment originating in the distal matrix projecting onto the ventral plate. Knowing this information prior to biopsy is helpful in choosing the type of plate avulsion and biopsy technique.⁷

LONGITUDINAL ERYTHRONYCHIA

Longitudinal erythronychia is a pink or red longitudinal band in the nail.⁸ Splinter hemorrhages and a chipped, onycholytic distal plate at the free edge of the nail often accompany it. The band usually develops secondary to a disease process or a space-occupying lesion in the distal

matrix. This causes loss of function of the distal matrix cells in a discrete area, which results in the outgrowth of a focally thinned ventral nail plate. The underlying nail bed swells into this groove, with its vascular bed pinched, causing erythema. Ordinary trauma in this region results in splinter hemorrhages. As the abnormally thinned plate grows out distally, it disintegrates with activities of daily living, resulting in distal chipping and reactive hyperkeratosis and multinucleate cells of the distal nail bed and hyponychium.

The differential diagnosis of localized longitudinal erythronychia (limited to one nail) includes onychopapilloma, wart, warty dyskeratoma, increased glomus bodies (with or without a formal glomus tumor), other vascular anomalies (including arteriovenous malformation), Bowen disease, or, rarely, basal cell carcinoma or amelanotic melanoma.^{8,9} Clinical diagnosis of longitudinal erythronychia can be difficult. Although no formal guidelines exist regarding criteria for biopsy of localized longitudinal erythronychia, the authors routinely biopsy all new, changing, atypical, or symptomatic bands, particularly in a high-risk digit, and approach each nail on a case-by-case basis.

BIOPSY PREPARATION AND CONSENT

Preoperative evaluation includes identifying patients at increased risk for complications, including those with hypertension, diabetes, peripheral vascular disease, peripheral neuropathies, immunocompromised states, or coagulopathies, or those at high risk for perioperative bleeding. As with any procedure, a detailed discussion of the risks and benefits of and alternatives to the procedure, with a thorough informed consent, is obtained.

STERILE PREPARATION AND ANESTHESIA

Both anesthesia and the nail surgery are performed after using antiseptic agents to cleanse the skin. These agents include isopropyl alcohol, povidone-iodine, chlorhexidine gluconate, and chloroxynol. The surgeries are performed under strict sterile conditions.

There are several techniques for achieving anesthesia of the distal digit, including distal wing blocks, proximal digital blocks, transthecal blocks, and a variety of regional blocks. The authors routinely utilize the distal wing block for digital anesthesia.¹⁰ It is a well-established, safe, well-tolerated, quick-onset technique that assists in providing

LONGITUDINAL MELANONYCHIA AND LONGITUDINAL ERYTHRONYCHIA

a bloodless field. In most instances, plain lidocaine, ropivacaine, or bupivacaine is utilized. The authors achieve a bloodless field without routine use of epinephrine and often employ a glove tourniquet, coupled with the fluid load of a distal wing block, to control bleeding during surgery. As a general rule, however, epinephrine is not contraindicated in most instances.¹¹⁻¹⁶

In a distal wing block, the digit is sterilized with an antiseptic solution. Lidocaine 1% without epinephrine is prepared in a 3-cc syringe with a 30-gauge needle. A handheld massager is placed on the appropriate metacarpal or metatarsal joint, or over the proximal phalanx, for tactile distraction. A cryogen spray is applied to the proximal nail fold immediately prior to superficial needle insertion and injection. The anesthesia is injected superficially to create a wheal. This process is continued around the nail folds, with care to inject slowly, and only in already anesthetized skin, until the nail unit is completely anesthetized. When performed properly, the distal digit appears swollen and pale at this point. The digit is then prepared again with an antiseptic surgical scrub, and a sterile glove is placed over the hand or foot. A small nick is made in the appropriate finger of the glove, which is then rolled down to the base of the digit and serves as a tourniquet during surgery. This can be tightened if needed by securing a hemostat to the rolled portion of the glove at the digital base and twisting it until the appropriate amount of pressure is produced.

For each of the following procedures, optimal results are achieved only with complete anesthesia, a strict sterile preparation, and a bloodless field. In most cases, the authors attempt to excise the lesion in order to prevent sampling error and to provide easier follow-up after surgery.

PUNCH BIOPSY OF THE NAIL MATRIX

A punch biopsy of the matrix is ideally suited to evaluate bands of longitudinal melanonychia measuring less than 3 mm in width and those that originate in the distal matrix, particularly in digits with a shorter matrix.³ In many instances, this excludes the great toe and thumb. In these scenarios, the origin of the band can be completely excised with a 3-mm or 3.5-mm punch biopsy and is unlikely to result in a permanent nail dystrophy. However, if the band measures wider than 3 mm or arises in a digit with a long matrix (such as the great toe or thumb), the punch is likely to incise rather than excise the lesion. Furthermore, if the pigmented band originates in the proximal matrix, a punch biopsy of any size risks a permanent dystrophy, split nail, or both. In such cases, other biopsy techniques may be more appropriate. Still, for many bands of longitudinal melanonychia, the punch biopsy is able to provide an excellent specimen in an efficient, simple, and easily reproduced procedure.

For the punch biopsy, the authors employ the following technique.^{3,17} The digit may be soaked in an antiseptic solution and warm water for 10 to 15 minutes to soften the nail plate. Any cuticle and proximal nail fold pigment is shaved to diagnose Hutchinson sign. This biopsy should be labeled as specimen 1. The proximal nail fold is reflected and a scalpel blade is used to make 1 or 2 oblique incisions in the proximal nail fold around the band. The proximal nail fold is then undermined above the nail plate with scissors and reflected with a skin hook or suture. The origin of the band is identified and confirmed with an assistant, and the punch is placed directly over the origin of the pigment in the matrix, sitting on the proximal plate (Figure 2). Manual pressure and a twisting motion are applied to the punch until it is advanced through the plate, matrix, and dermis, until meeting resistance from the underlying dorsal distal phalanx. Removal of the specimen is carried out with care, usually without forceps to prevent crush artifact. Instead, fine-tipped scissors are oriented and inserted perpendicularly to the digit in the circular cut made by the punch. Small snips with the tips of the scissors are made at the base of the specimen at the level of the periosteum. This is repeated until the specimen is released and labeled as specimen 2. Often, the overlying distal nail plate is separated



Figure 2. A punch biopsy of the nail matrix.

from the underlying matrix epithelium and is lodged in the punch instrument itself. This plate may contain important histologic information such as melanin, fungal material, hemorrhage, or bacteria. If separated, the plate specimen is removed from the punch, then labeled as specimen 3 and processed separately in formalin. The distal matrix defect resulting from a 3-mm or 3.5-mm punch biopsy does not require suturing and is left to heal by second intention. In some instances, the surgeon may then perform a larger punch or window avulsion of the surrounding plate, or a partial proximal plate avulsion, to inspect and explore the immediately surrounding tissue for additional pigmentation. If any additional pigment is identified, it too is biopsied in an effort to excise the lesion. The proximal nail fold is returned to anatomic position by releasing the skin hook or suture. There are then several appropriate options: a pressure dressing can be applied and the proximal nail fold will heal on its own; Steri-Strips can be placed over the oblique incisions to approximate the folds; or simple sutures can be placed and removed in 1 to 2 weeks. Petrolatum gauze is placed over the surgical site and a pressure dressing is applied. Mastisol is applied to the sides of the digit, and tape is used in a front-to-back and side-to-side manner to avoid circumferential taping that could act as a tourniquet. The physician removes the tourniquet and glove in each case. Patients are then observed for 15 to 20 minutes to ensure a dry surgical field.

MATRIX SHAVE

The matrix shave is a versatile way to obtain matrix tissue, particularly in the setting of longitudinal melanonychia.^{2,3,18} The advantages of this technique are that both thin bands (less than 3 mm in width) and wider bands (up to 6 mm in width) can be excised in toto and that scarring of the matrix (even the most proximal portion) is minimized. However, the procedure is more technically difficult to perform than the punch biopsy and requires experience and confidence with nail surgery.³

The proximal nail fold is inspected and any pigment is shaved. The proximal nail fold is then reflected as previously described. The matrix is exposed with a partial nail plate avulsion. The authors prefer to perform either a partial proximal plate avulsion or lateral nail plate curl.⁷ Once the entire matrix is visualized, the origin of the pigmented band is identified and confirmed with an assistant. A Teflon-coated No. 15 blade is used to score around the origin of the band with margins of 1 to 2 mm (Figure 3). The blade is then flattened almost parallel to the surface of the matrix epithelium. Using a very delicate gliding motion, the blade is passed superficially beneath the scored specimen until the tissue is freed and sitting on top of the blade. No forceps are used in this process.



Figure 3. Nail matrix shave.

The average thickness of the specimen is less than 1 mm. The specimen is then placed on a nail map or a piece of cardboard, covered with foam, put in a cassette, and then placed in formalin. This prevents the specimen from curling and facilitates proper embedding in the histology lab. Inking is optional but may assist the pathologist in specimen orientation. The resulting defect is left to heal by second intention. The partially avulsed plate is trimmed laterally (to avoid embedding with postoperative swelling) and returned to anatomic position. The plate and folds are sutured, the digit dressed, the tourniquet removed, and the patient observed as described for the matrix punch excision.

LONGITUDINAL MIDLINE/ PARAMEDIAN EXCISION

In the evaluation of longitudinal melanonychia, longitudinal excision is most appropriate in the setting of a long matrix (often observed on the thumb and great toe), where the band is longer than it is wide and where a punch will be incisional rather than excisional.¹⁸ The longitudinal midline/paramedian excision is also indicated with suspicion of an invasive tumor and when the surgeon plans to reconstruct the resultant defect. It has utility in bands originating in the proximal, mid, and distal matrix.

The proximal nail fold is inspected and any pigment is shaved. The proximal nail fold is then reflected as previously described. The matrix is exposed with a partial

proximal avulsion or lateral nail plate curl.⁷ The origin of tumor is identified in matrix and confirmed with an assistant. The origin of the band is scored as a longitudinal ellipse with margins of 1 to 2 mm (Figure 4). Such an ellipse may extend into the nail bed distally and to the proximal cul-de-sac, or occasionally onto the eponychium proximally. The tissue is excised with minimal crush artifact using fine-tipped scissors and judicious use of forceps. The scissors are oriented with the tips down during this dissection to maintain the deep plane over the periosteum for the entire length of the excision. The specimen is oriented on a nail map, with or without inking, and placed in a cassette and then in formalin.

Without proper reconstruction, this full-thickness longitudinal defect will contract and likely result in a split nail. The repair can be performed with undermining and primary closure or a variety of nail flaps. The nail is undermined sharply with the scalpel blade, sweeping in the plane above the periosteum 360° around the defect, releasing all restraint. For narrow defects, simple undermining facilitates simple primary repair using buried absorbable sutures. The authors prefer to use rapidly absorbable polyglactin 910 sutures. In broader defects, or in those with more restraint, a bipedicle flap, distal bilateral rotation flap, or proximal bilateral advancement flap can be utilized. Detailed instruction for these more complicated procedures can be found elsewhere.^{18,19}

After matrix reconstruction, the partially avulsed plate is trimmed laterally (to avoid embedding with postoperative

swelling) and returned to anatomic position. The plate and folds are sutured, the digit dressed, the tourniquet removed, and the patient observed as described for the matrix punch excision.

LONGITUDINAL EXCISION ORIENTED SPECIFICALLY FOR LONGITUDINAL ERYTHRONYCHIA

Longitudinal excision is the biopsy technique of choice for most cases of longitudinal erythronychia. In most cases, the relevant pathology involves the distal matrix and commonly extends onto the nail bed. Therefore, a longitudinal fusiform excision starting at the mid and distal matrix, extending through the bed, is ideal to completely evaluate and extirpate any primary tumor while maximizing a functional and aesthetic nail.

The band is marked preoperatively on the proximal nail fold and distal digital tip, as the band may become more inconspicuous when the digit is anesthetized. The nail plate is avulsed, either as a partial midline plate avulsion, lateral nail plate curl, or trap door avulsion.⁷ The matrix and bed are inspected and the lesion identified. A No. 15 blade is used to score around the lesion with margins of 1 to 2 mm, creating a fusiform excision oriented longitudinally, starting in the mid to distal matrix and carried to the hyponychium (Figure 5). The lesion is excised distal to proximal at the level of the periosteum with fine-tipped scissors. The scissors are oriented with the tips down during this dissection to maintain the deep plane over the

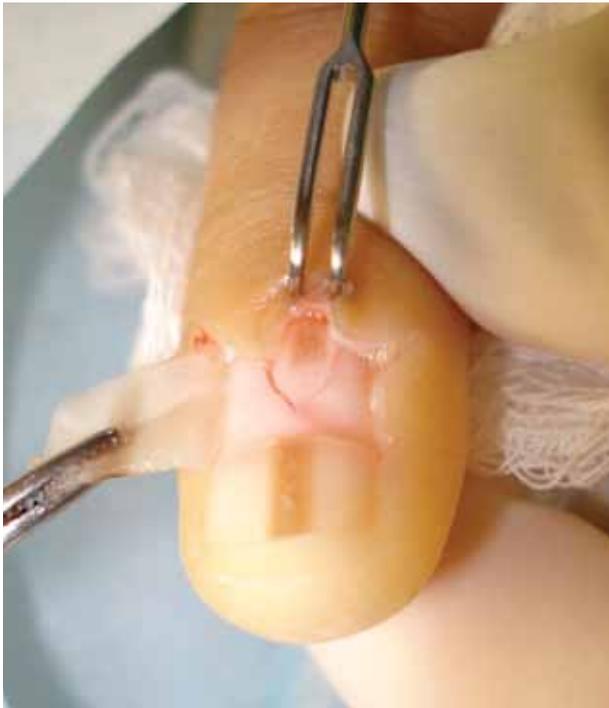


Figure 4. A longitudinal midline/paramedian excision of the nail matrix in the setting of longitudinal melanonychia.



Figure 5. A longitudinal excision of the nail matrix and bed in the setting of longitudinal melanonychia.

periosteum for the entire length of the excision. If possible, forceps are avoided. The specimen is oriented on a nail map, with or without inking, and placed in a cassette with clear instructions to section longitudinally during processing. The entire defect can be left to granulate, or the distal matrix can be closed using absorbable sutures. If the matrix is difficult to approximate, wide lateral undermining, a nail matrix flap, or both may be utilized. As the defect is predominantly in the distal matrix, many of these are allowed to heal by second intention and with minimal dystrophy. The nail plate is returned to anatomic position and secured in place with sutures. The digit is dressed, the tourniquet removed, and the patient observed as described for the matrix punch excision.

HORIZONTAL CRESCENTIC EXCISIONAL BIOPSY

Horizontal crescentic excision has been advocated as the ideal technique for most matrix biopsies because of the ease of closure and low likelihood of subsequent split or dystrophic nail. However, for longitudinal melanonychia and erythronychia, it is conceptually flawed. Pathologically, both are oriented longitudinally in the nail unit, and transversely oriented surgeries tend to be incisional rather than excisional. However, for diagnostic biopsy of inflammatory matrix diseases or for intended incisional sampling of a tumor, transverse biopsy is appropriate.

The entire matrix is exposed with reflection of the proximal nail fold and lateral nail plate curl or partial proximal plate avulsion.⁷ The lesion, either pigmented, neoplastic, or inflammatory, is identified and confirmed with an assistant. A scalpel blade is used to score around the lesion with margins of at least 1 to 2 mm. The incisions are made to parallel the lunula in a crescentic manner to include an adequate sampling of the tumor or inflammatory condition. Fine-tipped scissors are oriented with the tips down, and the scored tissue is removed at the level over the periosteum. If possible, forceps are avoided to reduce crush artifact. The sample is oriented on a nail map in a cassette and placed in formalin. Distal matrix defects can be left to granulate or can be partially or completely sutured. Proximal matrix defects are repaired with wide undermining, relaxing incisions, or both at the junction of the lunula and nail bed. If unrepaired, a bilayered nail with marked onychoschizia may result. If the majority of the matrix is removed with the biopsy, one may complete a total matrix excision, including the matrix horns, to avoid a severely dystrophic or cosmetically deformed nail, the formation of nail spicules, or remnant cysts. The nail plate and proximal nail fold are replaced and secured in the desired fashion. The digit is dressed, the tourniquet removed, and the patient observed as described for the matrix punch excision.

LATERAL LONGITUDINAL BIOPSY

Lateral longitudinal biopsy is the preferred technique to evaluate longitudinal melanonychia and erythronychia located on the lateral 30% of the nail.^{3,20} This procedure offers a reliable excision, avoids sampling error, and preserves a functionally and cosmetically acceptable nail. It may also be performed to diagnose inflammatory conditions of the nail unit, as it samples each of the nail subunits: proximal nail fold, with or without lateral nail fold, proximal and distal matrix, bed, plate, and hyponychium (Figure 6).

The procedure is described in the setting of laterally located longitudinal melanonychia.³ The digit is soaked in an antiseptic bath mixed with warm water for 10 to 15 minutes to soften the plate. The excision is designed before anesthesia is injected. The skin is marked with a surgical pen, starting at 75% of the distance between the cuticle and the distal interphalangeal crease, extended distally with margins of 1 to 2 mm medial to the pigmented band, on the nail plate and over the free edge/hyponychium, terminating approximately 2 to 3 mm onto the digital tip. A line is then made from the starting point, extended proximally and laterally to the distal interphalangeal crease to create a fusiform shape (which facilitates repair of the defect) and ensuring complete removal of the lateral matrix horn. From the most proximal point, a relatively straight line is drawn through the lateral nail sulcus and extended to meet the first line at the digital tip. A small segment of lateral nail fold is included in this last line if the pathology involves that nail subunit. A



Figure 6. A lateral longitudinal excision of the nail matrix.

No. 15 scalpel blade is used to incise the marked surgical site, carried to the level of bone. If the nail plate is adequately softened through preoperative soaking, minimal pressure is required to cut through it. Fine-tipped scissors are used to complete the excision, moving distal to proximal at the level of the periosteum. If possible, forceps are avoided to reduce crush artifact. The specimen is oriented on a nail map, with or without inking, and placed in a cassette with clear instructions to section longitudinally during processing. A small curette may be used in the proximal defect in the region of the matrix horn to debride any possible matrix remnants that can result in postoperative cysts and spicules.

Reconstruction is simple and primary, approximating the skin at the poles of the excision and reconstructing the lateral nail fold with a horizontal mattress suture through the nail plate. A No. 11 blade can be used to create holes in the plate to facilitate suture-needle passage. The digit is dressed, the tourniquet removed, and the patient observed as described for the matrix punch excision.

SUMMARY

In the setting of longitudinal melanonychia and longitudinal erythronychia, the previously described techniques are used to accomplish 3 fundamental goals of nail surgery: (1) obtain adequate tissue via an excisional biopsy to make an accurate diagnosis and avoid sampling error; (2) avoid unnecessary trauma to surrounding nail tissues by the judicious use of partial plate avulsions whenever feasible; and (3) avoid unnecessary postoperative nail scarring whenever possible. When the patient is comfortable and the physician is confident, nail surgery is a satisfying and important part of the practice of dermatology.

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