

## HEALTH BENEFITS OF TOPICAL MAGNESIUM SULFATE CREAM ON FINGER AND TOENAIL MATRIX

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### INTRODUCTION

The nail consists of the nail plate, the nail matrix and the nail bed below it, and the grooves surrounding it. A healthy nail has the function of protecting the distal phalanx, the tip of the distal phalanx, and the surrounding soft tissues from injuries. It also serves to enhance precise delicate movements of the distal digits through counter-pressure exerted on the pulp of the finger or toe. The nail then acts as a counter-force when the end of the digit touches an object, thereby enhancing the sensitivity of the tip, although the nail itself has no nerve endings. Finally, the finger nail functions as a tool enabling a so-called "extended precision grip" (e.g. pulling out a splinter in one's finger), and certain cutting or scraping actions.

The nail matrix is where fingernails or toenails form. A healthy nail matrix is essential for healthy nails. A variety of conditions and injuries can damage the nail matrix. In many cases, the nail matrix will heal spontaneously with proper care.

### The nail matrix: anatomy, function, and nail growth



#### General anatomy of the nail and surrounding soft tissues

The nail matrix is where fingernails and toenails start to generate. The nail matrix consists of two parts: the germinal matrix and the sterile matrix.

The nail's germinal matrix is under the base of the nail, and the sterile matrix lies underneath the nail. Most of the nail's matrix is invisible. The lunula (white crescent shape at the base of the nail) is the only visible part of a nail's matrix. However, some individuals do not have visible lunulas, which is not an abnormality.

The nail matrix and lunula are part of the nail's overall structure, which also includes:

- Cuticle: white or transparent skin at the nail base.
- Lateral nail fold: skin on either side of the nail.
- Nail plate proper.
- Nail bed: area beneath nail plate.
- Proximal nail fold: skin at the base of nail just distal to cuticle.

The nail matrix is made of special cells whose main purpose is to grow new fingernails or toenails. Each nail matrix produces 196 layers of cells that combine to create fingernails and toenails. Each nail matrix is continuously producing new nail cells, unlike hair follicles which go through periods of intermittent pause.

The germinal matrix is responsible for about 90% of all nail growth, whereas the sterile matrix is responsible for the remaining 10% of cells. The sterile matrix is particularly important for nail attachment to the underlying skin.

The growing part of the nail is under the skin at the nail's proximal end under the epidermis, and that is factually the only living part of a nail.

In mammals, nail growth rate is related to the length of the distal phalanges. Consequently, in humans, the nail of the index finger grows faster than that of the little finger, and fingernails grow up to four times faster than toenails.

In humans, fingernails grow at an average rate of approximately 3.5 mm (0.14 inch) per month, whereas toenails grow about half as fast (approximately 1.6 mm (0.063 inch) per month). Fingernails require 3 to 6 months to regrow completely, and toenails require 12 to 18 months. The actual growth rate is also dependent upon age, sex, season, exercise level, diet, and hereditary factors. The longest female nails known ever to have existed measured a total of 8.65 meters (28 feet 4.5 inch). Contrary to popular belief, nails do not continue to grow after death; postmortem the skin dehydrates, tightens, and retracts, making the nails (and hair) appear to grow further.<sup>[1]</sup>

Local injuries as well as certain health conditions can damage the nail matrix and interfere with nail growth.

Minor damage to the nail matrix can temporarily change the nail's appearance, with visible bruising, ridges, dents, uneven surface.

More severe injuries can cause a nail to fall off. Once the nail matrix heals, the nail will usually start to re-grow spontaneously. It may take several weeks before a new nail becomes perceptible.

In cases of very severe nail matrix damage, some or all of the damaged nails may not grow back at all.

### Nail permeability

The nail is often considered an impermeable barrier, but this is untrue. In fact, it has been demonstrated to be more permeable than the skin,<sup>[1]</sup> and the composition of the nail includes 7-12% water. This permeability has implications for penetration by medicinal substances but also by harmful chemicals. Therefore, particular cosmetics applied to the nails can pose a risk. Examples are paraquat, a fast acting herbicide that is harmful to humans, urea which is often an ingredient in creams and lotions meant for use on hands and fingers, several fungicidal agents such as salicylic acid, miconazole (e.g. Monistat®), and sodium hypochlorite which is the active ingredient in common household bleach (be it usually only in 2-3% concentration).

### Health conditions affecting the nail matrix

Any change to the appearance or texture of one or more of the nails could be a sign of a nail matrix problem. If nail matrix damage or a condition affecting the nail matrix occurs, nails may show.

- Dents (large or small).
- Horizontal ridges or lines.
- Pain or soreness.
- Splits or cracks.
- Spots or streaks of color.
- Texture changes, e.g. becoming thicker or crumbly.

Several health conditions and other factors can affect the nail matrix, including.

- Fungal infection: Certain types of fungus (mold) can infect nails, usually toenails. Toenail fungus may appear as thick, yellow, cracked or cloudy nails.<sup>[3]</sup>
- Illnesses: A serious health event like a heart attack or an illness like COVID-19 or pneumonia can interrupt new nail growth and can cause Beau's lines (horizontal ridges) in nails.
- Injuries: Pinching or crushing a finger or dropping a heavy object on a toe can traumatize the nail matrix. After a nail matrix injury, there will be visible bruising, ridges or discoloration. The affected nail may fall off. Some injuries to fingernails or toenails can cause a secondary nail infection.
- Medications: Chemotherapy and other medications can temporarily affect the nail matrix, causing Beau's lines or slow nail growth. Medications may also cause Mees' lines (white bands across your nails) and nail discolorations. Usually, these disappear after stopping the medication.
- Peripheral artery disease (PAD): PAD causes less blood flow to legs and feet, affecting the nail matrix with slowing of nail growth.

Additionally, certain skin conditions and systemic diseases<sup>[6]</sup> can affect the nail matrix, such as:

- Eczema: Severe eczema can affect the nail matrix and temporarily interfere negatively with nail growth. Beau's lines, pitting (small, pinhole-like dots) and texture or discolorations may appear.<sup>[3]</sup>
- Psoriasis: Up to 80% of people with psoriasis also develop nail psoriasis. Psoriasis can cause nail changes, e.g. white lines, pitting and crumbling.
- Subungual melanoma: Nail matrix melanoma, also called subungual melanoma, is a type of skin cancer that affects the nail matrix. Brown or black discoloration on the nail is the most common sign. Imminent medical attention is necessary with any color changes in a single nail.

It can be difficult differentiating between a harmless nail change and one that requires medical treatment. Not all nail changes mean the nail matrix itself is also damaged. Some nail problems affect the nail bed, nail plate or nail folds, but not the nail matrix.

Upon noticing any change to fingernails or toenails, from a small spot of color to lines or ridges, it is advisable to consult with a health care professional who can determine the cause and recommend treatment, if needed.

### Treatment of nail matrix conditions

Treatment for a nail matrix condition depends on the cause.

Medication: Prescription antifungal pills are the typical treatment for nail fungus. Against nail psoriasis, certain medications can help manage the condition. These may include pills, injections or topical treatments, depending on the needs.

**Relieving nail injuries:** A bruise under the nail may benefit from a procedure to drain the trapped blood. This procedure, called nail trepanation, provides pain relief and supports new nail growth. Providers must perform this procedure within 48 hours of injury, before the blood has clotted.

**Surgery:** Subungual melanoma needs to be surgically removed. A biopsy may be necessary to establish the diagnosis. If the biopsy shows melanoma, the affected area in the nail matrix and under the nail will have to be excised. If the cancer has spread, other treatments may be required, e.g. chemotherapy or radiation.

### General care and recommendations for nail matrix health

In daily life, local trauma with nail matrix injury is almost unavoidable, especially in the hands, and in children.

However, appropriate nail matrix care can help prevent problems.

- **Proper cutting and filing nails:** toenails need to be trimmed regularly, and straight across to help prevent ingrown toenails. Fingernails should be trimmed not too short and with a slight curve at the edges. Manipulation of the cuticle has to be avoided, either at home or by a pedicure. Filing is also recommended, so as to keep nails from becoming too rough and to remove any small bumps or ridges. To avoid transmission of infections, only after proper disinfection should nail tools be used by different people.
- **Managing general health conditions:** When suffering from a condition that can also affect nails, e.g. psoriasis, a health care provider needs to be consulted regularly to control or improve that specific condition.
- **Minimizing foot fungus risk:** Barefoot in public bathrooms or locker rooms, or swimming pools, where foot fungi commonly thrive, is to be avoided
- **Hand protection:** If working with tools or machinery, be familiar with “pinch points” that could injure fingers or hands. Gloves should be worn upon employer’s advice and when working with chemicals.
- **Treatment for nail changes or injuries** should not be delayed: If a nail shows color changes, pitting, ridges, lines, or texture changes, a provider should be consulted.
- **Wear of proper footwear:** When playing sports, correct shoes for that type of sports and accurate size should be ensured. Steel-toe boots are appropriate to protect the toes when working with heavy objects or in construction labor.

The nail matrix is the “factory” where the body forms new finger and toenails. Certain injuries and illnesses can damage the nail matrix and affect how nails look or grow. But with the right treatment, often healthy nails

grow again. Even if a nail falls off, it usually grows back with proper medical care.

It is rare for the nail matrix to be permanently damaged, preventing a nail from growing back. Over time, one is very likely to become used to an absent nail. Nevertheless, care needs to be taken to prevent possible future re-injury.

### Other clinical inferences and considerations



*Thumbnail of the right hand with cuticle (upper left) and hangnail (top)*

Healthcare and pre-hospital-care providers (EMTs or paramedics) often use the fingernail beds as a cursory indicator of distal tissue blood perfusion in individuals who may be dehydrated or in shock. However, this test is not considered reliable in adults. This is known as the CRT or blanch test. In this test the fingernail bed is briefly depressed to turn the nail-bed white. When the pressure is released, the normal pink color should be restored within a few seconds. Delayed return to pink color can be an indicator of certain shock states such as hypovolemia.<sup>[2]</sup>

Blue-ish or purple fingernail beds may be a symptom of peripheral cyanosis, which is indicative of oxygen deprivation.

Nail growth record can show the history of recent physiological imbalances in general health conditions, and has been utilized as a diagnostic tool since ancient times.

Deep, horizontally transverse grooves from cuticle to nail tip known as "Beau's lines" may form across the nails. These lines are usually a natural consequence of aging, but they may occasionally result from disease. Discoloration, thinning, thickening, brittleness, splitting, grooves, Mees' lines, small white spots, receded lunula, clubbing (convex), flatness, and spooning (concave) can indicate illness in other areas of the body, nutritional deficiencies, drug reactions, poisoning, or merely local injury.

Nails can also become thickened (onychogryphosis), loosened (onycholysis), infected with fungus (onychomycosis), or degenerate (onychodystrophy). A common nail disorder is an ingrown toenail (onychocryptosis).

Finger and toenails (as well as hairs) can be used for DNA profiling in forensic medicine.

### Nutritional aspects of nail health

Biotin (vitamin B7) containing foods and supplements may help strengthen brittle fingernails.

Vitamin A is an essential micronutrient for vision, reproduction, cell and tissue differentiation, and immune function.

Vitamin D and calcium work conjointly in maintaining homeostasis, creating muscle contraction, transmission of nerve pulses, blood clotting, and membrane structure. Lack of vitamin A, vitamin D, or calcium can cause nail dryness and brittleness.

Insufficient vitamin B12 can lead to excessive dryness, darkened nails, and rounded or curved nail ends. Insufficient intake of both vitamin A and B results in fragile nails with horizontal and vertical ridges. Some over-the-counter vitamin supplements such as certain multivitamins and biotin may help in growth of strong nails, although this is fairly subjective. Both vitamin B12 and folate play a role in red blood cell production and oxygen transportation to nail cells. Inadequacies can result in discoloration of the nails.<sup>[4]</sup>

Low dietary of omega-3 fatty acids may contribute to dry and brittle nails.

Protein is a building material for new nails. Therefore, low dietary protein intake may cause anemia and the resulting reduced hemoglobin in the blood filling the capillaries of the nail bed reflects varying amounts of light incident on the nail matrix resulting in lighter shades of pink ultimately resulting in white nail beds when hemoglobin is very low. When hemoglobin is close to 15 or 16 grams per deciliter (gm/dL), most of the spectrum of light is absorbed and only the pink color is reflected back and the nails look pink.



Essential fatty acids play a significant role in healthy skin as well as nails. Splitting and flaking of nails may be due to a lack of e.g. linoleic acid.

Iron-deficiency anemia can lead to a pale color along with a thin, brittle, ridged nail texture. Iron deficiency in general may cause the nails to become flat or concave, rather than convex. As oxygen is needed for healthy nails, an iron deficiency or anemia can lead to vertical ridges or concavity in the nails. Recommended Dietary Allowance (RDA) for iron varies considerably depending on age and gender. The recommendation for men is 8 mg per day, while that for women aged 19-50 is 18 mg per day. For women over the age of 50, or during menopause, the iron needs decrease to 8 mg daily.<sup>[5]</sup>

Manicures and pedicures are cosmetic as well as health procedures to groom, trim, and paint the nails and manage calluses. They require various tools such as cuticle scissors, nail scissors, nail clippers, and nail files. Artificial nails can also be fixed onto real nails for cosmetic purposes.

Painting nails with colored nail polish/lacquer/varnish to improve the cosmetic appearance is a common practice dating back to at least 3000 BC.

### Local magnesium and nail health

We had previous experience with the capability of magnesium sulfate cream to be easily absorbed in superficial as well as deeper tissues when applied locally. This, and the fact that nails are highly permeable made us inquisitive to evaluate its use on nails.

The first author of this article has used magnesium sulfate crème daily on all finger and toe clefts plus the corresponding joint, to ensure absorption of magnesium sulfate into tissues to strengthen the nails and associated joints. She has noticed that she does not have Heberden's nodes, hang nails or joint arthritis.



*Right hand and left foot of 77 year old female, chronically using magnesium sulfate cream on all hand and toe nails, and on all phalanges.*

*Note the absence of Heberden nodules or other degenerative deformities.*



**REFERENCES**

1. Yaemsiri, S, Hou, N, Slining, M, He K. (2010). Growth rate of human fingernails and toenails in healthy American young adults. *Journal of the European Academy of Dermatology and Venereology*, 24(4): 420-423. doi:10.1111/j.1468-3083.2009.03426.x. ISSN. PMID 19744178. S2CID 856692.
2. Schriger DL, Baraff LJ (June 1991). Capillary refill -is it a useful predictor of hypovolemic states? *Ann Emerg Med*, 20(6): 601-615. doi:10.1016/S0196-0644(05)82375-3. PMID 2039096.
3. Denning, DW; Evans, EG; Kibbler, CC; Richardson, MD; Roberts, MM; Rogers, TR; Warnock, DW; Warren, RE (November 11, 1995). Fungal nail disease: a guide to good practice (report of a Working Group of the British Society for Medical Mycology). *British Medical Journal*, 311(7015): 1277-1281. doi:10.1136/bmj.311.7015.1277. PMC 2551187. PMID 7496239. Institutes of Health. 10 January 2022. Retrieved 15 July 2023.
4. Langan, Robert C.; Zawistoski, Kimberly J. (15 June 2011). Update on Vitamin B12 Deficiency. *American Family Physician*, 83(12): 1425-1430. PMID 21671542.
5. Singal, Archana; Arora, Rahul (2015). Nail as a window of systemic diseases. *Indian Dermatology Online Journal*, 6(2): 67-74. Doi:10.4103/2229-5178.153002. PMC 4375768. PMID 25821724.
6. Chu J, Bruyninckx F, Goodman S. Possible role of topical magnesium sulfate in improving growth and strength of scalp hair. *EJPMR*, 2025; (12/2) 53-55.