The Foot--The Natural History of an Appendage

Dr. Kenneth Proefrock

The human foot contains 26 bones, 33 joints, and over 100 muscles, tendons, and ligaments, all wrapped together in layers of fascia and working with a coordinated effort to support and move the body, while allowing for a range of movements that include the delicate balance required for tiptoeing to the powerful thrust needed for sprinting. The arches of the foot represent an architectural marvel, absorbing and distributing the impact of each step, reducing stress on the rest of the body and maintaining overall stability and balance. Feet are also at the bottom of us, closest to the ground and subject to a certain amount of abuse and neglect. The daily activities of walking, jumping, and running, can lead to inflammation, bruising, and strain/sprain injuries, and the primary causes for foot pain today are improper footwear, diabetes and inactivity.

In order to discuss the various conditions that can affect the foot and ankle, it may be important to understand the normal anatomy of the foot and ankle. The ankle itself consists of three bones attached by muscles, tendons, and ligaments that connect the foot to the leg. The major bones of the lower leg are the tibia and the fibula. These bones articulate with the talus or ankle bone at the tibiotalar joint (literally where the tibia meets the talus-ankle joint) allowing the foot to move up and down.

The foot can be divided into three anatomical sections called the hind foot, mid foot, and forefoot. The hind foot consists of the talus bone, the highest bone in the foot, and the calcaneus, the heel bone, which is also the largest bone in the foot. The hind foot connects the mid foot to the ankle at the transverse tarsal joint. The mid foot contains five tarsal bones: the navicular bone, the cuboid bone, and 3 cuneiform bones. It connects the forefoot to the hind foot with muscles and ligaments, primarily the plantar fascia ligament. The mid foot is responsible for forming the arches of your feet and acts as a shock absorber when walking or running. The forefoot consists of the long bones in the feet, the metatarsal bones, and the toe bones, the phalanges, which connect with one another at the ball of the foot by joints called phalangeal metatarsal joints. Each toe has 3 phalange bones and 2 joints, while the big toe contains two phalange bones, two joints, and two tiny, round sesamoid bones that enable the toe to move up and down. Sesamoid bones are bones that develop inside of a tendon over a bony prominence. The first metatarsal bone connected to the big toe is the shortest and thickest of the metatarsals and is the location for the attachment of several tendonsand is important for its role in propulsion and weight bearing.

The foot and ankle bones are held in place and supported by various soft tissues.

- **Cartilage**: Shiny and smooth, cartilage allows smooth movement where two bones come in contact with each other.
- **Tendons**: Tendons are soft tissue that connects muscles to bones to provide support. The Achilles tendon, also called the heel cord, is the largest and strongest tendon in the body. Located on the back of the lower leg it wraps around the calcaneus.
- Ligaments: Ligaments are fascial structures that are strong rope-like tissues that connect bones to other bones, stabilize tendon positions and provide stability to the joints. The plantar fascia is the longest ligamentous structure in the foot, originating at the calcaneus and continuing along the bottom surface of the foot to the forefoot. It is responsible for the arches of the foot and provides shock absorption. Plantar fasciitis happens when repetitive micro tears occur in the plantar fascia from overuse. Ankle sprains, the most commonly reported injury to the foot and ankle area, involve ligament strain, and usually occur to the talo-fibular ligament and the calcaneo-fibular ligament.
- **Muscles**: Muscles are fibrous tissue capable of contracting to cause body movement. There are 20 muscles in the foot and these are classified as intrinsic or extrinsic. The intrinsic muscles are those located in the foot and are responsible for toe movement. The extrinsic muscles are located outside the foot in the lower leg. The gastrocnemius or calf muscle is the largest of these and assists with movement of the foot. Muscle strains occur usually from overuse of the muscle in which the muscle is stretched without being properly warmed up.
- **Bursae**: Bursae are small fluid filled sacs that decrease friction between tendons and bone or skin. Bursae contain special cells called synovial cells that secrete a lubricating fluid.
- **Fascia**: Fascia is, literally, the biological fabric that holds our body together, a three-dimensional spider web of fibrous, gluey, and wet proteins that acts like a bracing and organizing scaffold for the physical form. Understanding fascia is essential to understanding the dance between static and dynamic bodily processes, between the experience of pain and that of comfort, it is crucial to physical performance, central to recovery from injury and disability, and an ever-present participant in our daily quality of life. Here, and for our purposes, 'fascia' has to be given a broader biological definition, it is, effectively, all of the collagenous-based soft-tissues in the body, including the cells that create and maintain that network of extra-cellular matrix (ECM). Fascia is one single, vastly interconnected, biomechanical regulatory system with millions of tiny nerves moving in and out of adjacent sheets of fascial material, into and out of contained compartments of fluid

within muscles, organs and skin. Not only does it represent a structurally critical component of the physical form, it also acts to transmit information and resources throughout the system, often faster and more deliberately than other bodily communication systems. Fascia is a resonant, vibratory structure...if you have ever gone to a concert and stood too close to the speakers and you feel that vibration go through your entire being, those vibrations are being carried through the fascial system.

Biomechanics is a term to describe movement of the body. The ankle joint by itself permits two movements:

- **Plantar flexion**: Pointing the foot downward. This movement is normally accompanied by inversion of the foot.
- **Dorsiflexion**: Raising the foot upward. This movement is normally accompanied by eversion of the foot.

The foot (excluding the toes) also permits two movements:

- **Inversion**: Turning the sole of the foot inward.
- Eversion: Turning the sole of the foot outward

The toes allow four different movements:

- Plantar flexion: Bending the toes towards the sole of the foot
- **Dorsiflexion**: Bending the toes towards the top of the foot
- Abduction: Spreading the toes apart. This movement normally accompanies plantar dorsiflexion.
- Adduction: Bringing the toes together. This movement normally accompanies plantar flexion.

Feet have been a source of certain fascination for humans the world over from time immemorial. The earliest known hominids, such as Ardipithecus ramidus and Australopithecus afarensis, had feet that were adapted for climbing trees, with flexible toes and a grasping big toe that could grip branches. As early hominids began to walk upright on two legs, their feet gradually evolved to support this new mode of locomotion. The arches of the foot developed to absorb shock and provide stability, while the toes became shorter and less flexible. Around 2 million years ago, the time of Homo erectus, the foot had become more like a modern foot in appearance, with a longitudinal arch and a non-grasping big toe that was aligned with the other toes. This allowed for more efficient walking and running. The evolution of the foot continued with the appearance of *Homo sapiens* around 300,000 years ago. The arches of the foot became more pronounced, providing greater shock absorption and helping to distribute weight more evenly across the foot¹. In the last few thousand years, the human foot has undergone further changes due to cultural factors such as footwear. Shoes have altered the shape of the foot, leading to a higher incidence of foot problems such as bunions, hammertoes, and flat feet².

Cultural factors have influenced the human relationship with their feet in a myriad of ways, from interesting sexual fetishes, to seemingly barbaric footbinding rituals, bracing and serial casting to create more attractive or more functional feet, to a renewed conversation about whether or not shoes are good for us or not so good for us. For sure, it is a complicated story and what we think we know about it may not be the truth of the matter^{3,4}. Some of the pertinent cultural factors have been embedded in that most revered of historical fictions, the fairy tale, in fact, potentially the very first story to be considered a fairy tale, Cinderella⁵. The earliest recorded story featuring a Cinderella-like figure dates to the 6th century BCE in Greece and features a woman named Rhodopis whose shoe is stolen by an eagle, who flies it all the way across the Mediterranean and drops it in the lap of an Egyptian king. A shoe dropping from the heavens felt enough like a supernatural sign that the king went on a quest to find the owner of the shoe, he eventually finds Rhodopis and marries her, lifting her from a lower social status to the highest social status. Another one of the earliest known Cinderella stories is the ninthcentury Chinese fairy tale, "Ye Xian", first published in the Tang dynasty compilation Miscellaneous Morsels from Youyang written around 850 by Duan Chengshi⁶. This story profiles a young girl named Ye Xian who is granted a wish by some magical bones, which she uses to create a gown and matching shoes in the hopes of finding a husband, eventually a monarch comes into possession of one of the shoes and goes on a quest to find the woman whose tiny feet will fit the shoe, he finds her and Ye Xian's beauty convinces the king to marry her-again, lifting a female from a lower social station to a higher one, at a time when marriage may have been the primary means of social mobility for women.

In total, more than 500 versions of the Cinderella story have been found throughout the world and the one that we might know best comes from a 17th century story with title character, Cendrillon, by Charles Perrault, the French writer credited with inventing Mother Goose and the fairy tale⁷. He cast the form that Cinderella would take for the next 400 years, introducing the glass slipper, the pumpkin, the wicked stepmother and stepsisters, and the fairy godmother, the version that Disney animated and injected into modern pop culture in the 1950's. Many fairy tales that have their roots in the 17th century, including Snow White and Hansel and Gretel, feature similar themes and especially evil stepmothers who seek to ruin the protagonist's lives. In all of these stories, the stepmother's primary enemy is her step-children, living, breathing reminders of her husband's first marriage, a situation made more complicated by stepchildren who adopt an anger and resentment on behalf of their birth mother (usually deceased) and become her proxy in their father's household. These represent cultural stereotypes, roles that are pre-written and too easy to adopt, and this is a problem just as relevant today as it was 500 years ago. Step-parents, historically, were a very common occurrence

not because of divorce and remarriage but because so many women died during childbirth. This meant the new wife (and her children) were in direct competition with the first wife's child not just for love and attention, but also for the inheritance that would decide which station of society they would belong to after the husband's death.

We know the gist of the story, Cinderella has unique feet, in some versions, she has perfect feet, and why a glass slipper? so you can see her perfect feet, like a type of voyeurism, seeing some seldom seen but perfect part of someone else's anatomy. It involves the innocent and abused Cinderella with her delicate features, and perfect feet, her narcisstic stepmother and stepsisters, and a handsome prince who is smitten by the owner of the special shoe. In the Grimm Brother's 1857 version, the stepsisters feet are much too large for the slipper, so their mother reassures them that once they become queen, they won't have to walk, one sister cuts off her heel while the other amputates a toe⁸. In Perrault's tale, their deception is revealed to the prince by two pigeons perching in a hazel tree with the following lines:

Looky, look, look At that shoe that she took, There's blood all over, her foot's too small, She's not the bride that you met at the ball⁹.

When the Prince slips the shoe onto Cinderella's foot, she is found to be a perfect fit in size and form. Her small foot becomes proof of her 'natural' superiority, with an inferred morality, intelligence and grace. Recall that in the 1950 animated version from Disney, the stepmother and stepsisters have oversized feet, bulbous noses, and hairy bodies, indicating their bestial, baser natures while Cinderella is small, delicate-featured and smooth-skinned. On the one hand, the story is about the right of innocent, honest, hardworking girls to ascend in the class structure, but also tied to a matrimonial attachment. On the other hand, and we can act like they aren't, but feet are also about sex, the prince may be the first recorded foot fetishist. Leading us to that strange domain of Freud, who identified feet as the primary sexual fetish, in fact, foot fetishes account for nearly half of all fetishes associated with body parts today; and footwear is the most popular non-bodily oriented fetish, capturing one-third of all fetishists.

Foot fetishism may have reached a cultural apex in Brazil in the mid-1980s with a movement called *Feetishism*, started by Glauco Mattoso, a blind Brazilian poet. He created this transgressive, consciously indecent theology that sought an unveiling of God's love though the power of *massagem linguopedal* or 'tongue-foot massage'. Adherents were encouraged to lick and kiss

the sweaty, filthy feet of the oppressed and the oppressors in an active demonstration of love and respect. Workers and the destitute, homophobes and policemen, were recipients of this sacramental act, which sought to invert positions of power through the giving and receiving of pleasure. Mattoso published *The Feetishist Handbook: Adventures and Readings from a Guy Crazy* for Feet and, when that book became a cult classic with hundreds of followers, he turned it into a cartoon called *The Adventures of Glaucomix*, *The Feetishist*¹⁰. Followers of Glaucomix kissed and licked feet in a religious rite of selfmortification and big-hearted human-sympathy for the unknowable 'Other'. This ideology of humility sought to give people permission to confront harmful hierarchies and injustices. It was clearly a fetishistic theology, not in the sense that Freud espoused (with his emphasis on castration and the female phallus) but in the sense of the fetish as a displacement of the object of desire: the object of desire being God, displaced to the feet of the poor, the sinning, and the sick. Feetishism was a unique movement that drew on ideas, symbols and practices that have been inherited from the ancient world. Notably, in India and in the middle east, the custom arose where hosts would wash the feet of visitors (*pedilavium*), in a ritual designed to transform Strangers into welcomed Guests. Krishna bathed the feet of the Brāhmanas in an act of service and humility. The patriarch of Islam, Judaism and Christianity, Abraham, offered to wash the feet of the angels invited to his tent while on their way to destroy Sodom and Gomorrah. Both Muslims and Jews ritually cleanse their feet before praying. In the New Testament, there are several references like that of the female sinner who washed Jesus' feet with her tears, kissed them, dried them with her hair, and then anointed them with ointment. During the Last Supper, Christ knelt before his disciples, and washed and kissed their feet: 'Do you understand what I have done for you?' he asked them Now that I, your Lord and Teacher, have washed your feet, you also should wash one another's feet. I have set you an example that you should do as I have done for you. Very truly I tell you, no servant is greater than his master, nor is a messenger greater than the one who sent him. Now that you know these things, you will be blessed if you do them'.

Washing someone's feet is a deeply humbling act of hospitality and service, it changes you and it changes them...and at least one of you has clean feet at the end. It speaks to a certain transformative power inherent in our lowest appendage.

Feet and their coverings have meaning, they connect us to the earth, they represent the paths we have tread and the work we have done, we talk about "walking a mile in my shoes" as a way for someone to understand us. Podoscopy was proposed as a 'science of the feet', propelled by the popularity of physiognomy, many practitioners claimed they could diagnose character by the shape and form of the foot. The practice was promoted by writers in the early 1800's with names like

'Philopedes' (literally 'foot lover'), who published in 1825 that 'if you may know a man from the bumps on his skull, the wrinkles on his face, or the characters of his hand-writing, so you may know him from the shape and outline of his feet. The shallowest of observers may clearly discern, in the capacious, full-grown, and well-formed foot, the plainest indications of a vigorous and masculine understanding. What eloquence in the bold sinew, in the strong tendon! What firmness exhibited by the sound hearty brown! No flabbiness, no superfluous flesh, nothing to impede the free use of the member! Can such a FOOT be given to a sluggard?"¹¹ Old ideas about perfection of the body equating to a perfection of character, and the other side of the coin, your personal imperfections evidenced by imperfections in your physical form. One author in Hearth and Home on 10 May, 1894, wrote that it was a 'fallacy' that, in women, 'small extremities signify high breeding'. He contended that small feet were not hereditary but were 'the gift of Nature, like a Cupid's bow mouth, golden hair, and dimples, but their possessor is usually as proud thereof as though she were their creator', he goes on to promote the view that the 'luckless... big-soled girl' should be deeply embarrassed by her appendages. He noted that such girls and women were acutely conscious of a 'short-coming in this matter of beauty' and so is likely to be 'anxious to please, and to win affection by other means than charms of person', because although 'the average man is never insensible to the charms of a tiny foot, he is not repelled by the sight of a large one if it be smartly and appropriately shod^{'11}. In stark contrast, men in rural areas like North Sumatra (Indonesia), share an overwhelming preference for women with large feet. And at least one major study revealed that the preference for large female feet was positively correlated with rural societies all over the world who have had the least exposure to the Western media¹².

There are few places on earth, and in history, that have taken foot modification to the extremes that China has with their obsession surrounding the 'three-inch golden lotus' feet of women and the controversial practice of footbinding. A practice that is said to have been inspired by a tenth-century court dancer named Yao Niang who bound her feet into the shape of a new moon and enamored the Emperor Li Yu by dancing on her toes inside a six-foot golden lotus. Foot-binding became very culturally entrenched and was once widespread throughout China, with significant major regional variations, for nearly one thousand years. In addition to altering the shape of the foot, the practice also produced a particular sort of gait that relied on the thigh and buttock muscles for support. From the start, foot-binding was imbued with erotic overtones. Gradually, other court ladies—with money, time and a void to fill—took up foot-binding, making it a status symbol among the elite. By the eighteenth century, Fang Xun (known as the 'Doctor of the Fragrant Lotus') recorded 58 different types of bound feet, which he put into five categories: lotus petal, new moon, harmonious bow, bamboo shoot, and water chestnut⁵. A small foot in China represented the height of female refinement and for families with marriageable daughters, foot size translated into its own form of currency and a means of achieving upward mobility. The most desirable bride possessed a three-inch foot, known as a "golden lotus." It was respectable to have four-inch feet—a silver lotus—but feet five inches or longer were referred to as iron lotuses, and did not translate well to marriage prospects. Feet-binding is a laborious and painful procedure, often starting when a girl was around six years of age and, by adulthood it was irreversible¹³. It is often (although not always) imposed upon young girls against their inclinations because the process is agonizing as it involves radical remodeling of bones and tissue and severely impedes a normal walking gait. The process begins with the feet soaked in hot water and toenails clipped short, the feet were massaged and oiled before all the toes, except the big toes, were broken and bound flat against the sole, making a triangle shape. Next, the arch was strained as the foot was bent double and the feet wrapped tightly using a silk strip measuring ten feet long and two inches wide. These wrappings were briefly removed every two days to prevent blood and pus from accumulating and to watch for infection in the foot, sometimes "excess" flesh was cut away or encouraged to rot. The girls had to walk long distances in order to speed up the breaking of their arches and remodeling of the feet, over time the wrappings became tighter and the shoes smaller as the heel and sole were brought closer together, the process was complete after two years. Once a foot had been crushed and bound, the shape could not be reversed without a woman undergoing the same pain all over again. In Cinderella's Sisters, historian Dorothy Ko argues that the western emphasis on 'cultural practices' such as foot binding recasts Chinese women as victims. Ko advises us to emphasize female agency, observing that 'a pair of shapely bound feet was the lifelong handiwork of women'. Ko points out that foot binding was 'not merely an announcement of status and desirability to the outside world, but also a concrete embodiment of self-respect to the woman herself' and could not have become so widespread, or lasted a thousand years, without their participation⁵.

The feet of professional dancers, especially ballerina's feet are also the product of agonizing labor, as such, suffering is an integral part of the art. As described in Dance is a Contact Sport (1974)¹⁴, the use of pointe shoes and the ways legs and feet must be positioned, forces dancers to..."*defy the principles of human design.... Human toes were not designed to stand on. Unfortunately, dancers know this very well, but they stand on them anyway.... When dancers learn to turn out 180 degrees from the hips, to dance on pointe, to hold their torsos high off their waists, to arch and point their feet unnaturally, the muscles involved in these operations are strengthened in one way but weakened in others". Other authors compare the pointe shoe to the rack and thumbscrew, with ballerinas' shoes*

often filling up with sweat and blood, having to be changed multiple times during every performance. Fractures and sprains are common. Most of the damage is not done by injuries but by 'chronically overburdening the body' through overwork, fatigue, ignoring aches, and incorrect technique but many dancers are unwilling to admit to injury for fear that it shows lack of dedication¹⁵. Edgar Degas was a French Impressionist artist famous for his pastel drawings, oil paintings and sculptures, he is especially identified with the subject of dance; more than half of his works depict dancers, and especially their feet. When he died in 1917, he left behind a legacy that captured the physical demands and often painful realities of ballet, his portraval of ballerina's feet was not about idealized beauty but rather about the physical demands, the pain, and the realities of a life dedicated to dance. Like the footbound women of China, the culture of pain that these broken feet embody also excite fetishistic interest. The bunions, blisters, ingrown toenails, and calluses that are routine for ballerinas are the equivalent of military feet in men. It is no coincidence that the military call them 'foot soldiers' and it is a part of military lore that 'an army lasts only as long as the feet of its infantryman'. Or, more poetically, 'Feet to the soldier are what tires are to the motor, wings to the bird' During the American Civil War, the Atlantic Monthly advised soldiers that the most important attribute for a soldier was 'good feet'.

The foot covering, the shoe, can be an *objet d'art*, a fetish, a sign of sexual preferences or moral attitudes, and a performance of gender and identity. The shoes that Vincent Van Gogh painted in 1886, simply titled 'A Pair of Shoes' has inspired some of the great philosophical reflections of the twentieth century. Martin Heidegger in his 'The Origin of the Work of Art' lectured about these shoes in 1935¹⁶: "Out of the dark opening of the worn out insides of the shoe-tool stares the toil of laborious steps. In the sturdy solid heaviness of the shoe-tool is stowed up the stubbornness of the slow trudge through the far-stretched and monotonous furrows of the field, over which a raw wind blows. On the leather lies the dampness and fullness of the soil. Under the soles slides the loneliness of the field path as evening falls. In the shoe-tool vibrates the silent call of the earth, its quiet bestowal of ripening corn and its unexplained self-denial in the desolate fallow of the winter field. Extending through this tool are the uncomplaining fear as to the certainty of bread, the wordless joy of once again having withstood need, the trembling before the arrival of birth, and the shaking at the surrounding threat of death. To the earth belongs this tool, and in the world of the peasant woman is it heeded. From out of this heeded belonging, the tool itself stands up in its resting-within-itself." Heidegger provides an interpretation of Van Gogh's painting that reveals both the 'Being' of shoes and the truth of the peasant women's entire world to us, because those shoes are a manifestation of that world.

Walking a mile in those shoes is to assume the social position of the original wearer.

The most common medical conditions that affect the foot include athlete's foot (Tinea pedis), bunions, diabetic neuropathy, ingrown toenails, Plantar fasciitis, heel spurs and Morton's neuroma. In many cases, there may not be a pre-existing effective intervention for the presenting condition and we have to create something unique to impact a unique presentation. Athlete's foot is a cutaneous fungal infection caused by a dermatophyte infection that is characterized by itching, flaking, and fissuring of the skin. It is very much associated with the dampness of the environment within the shoe and it may manifest in three ways: the skin between the toes may appear macerated (white) and soggy; the soles of the feet may become dry and scaly; and the skin all over the foot may become red, and vesicular eruptions may appear. It effects 15-25% of the population at any given time, and is a very contagious condition that is often contracted from public showers and locker rooms and can spread to any area of the body, with groin and armpits being very common. Conventional interventions includes anti-fungal agents like allylamines and azoles, some of which are used topically and others internally.

The allylamines were introduced in the 1980s as agents that exhibited a broader spectrum of fungicidal activity against dermatophytes such as Trichophyton rubrum, T mentagrophytes, T tonsurans, Candida spp and *Epidermophyton floccosum*¹⁷. They work by inhibiting squalene epoxidase, an essential enzyme in the ergosterol biosynthesis pathway of fungal cell membrane formation. The two primary antimycotics in the allylamines family are terbinafine and naftifine. Benzylamines are another class of antifungals that are structurally similar to the allylamines. They operate via a similar mode of action, blocking the epoxidation of squalene. Butenafine is the representative drug in this class. Naftifine is a synthetic allylamine derivative that was incidentally discovered from research into new agents for the treatment of central nervous system disorders. Terbinafine was developed in 1979 by chemical modification of naftifine. They act by inhibiting the enzyme squalene 2,3-epoxidase that converts squalene to squalene oxide. Systemic absorption is approximately 6% of the applied dose after a single topical application, they are highly lipophilic and exhibit good penetration into the stratum corneum and hair follicles, they are both available in a 1% concentration in gel and cream forms. Terbinafine is well absorbed from the gastrointestinal tract after oral administration, with the peak plasma concentration of 1 µg/mL detected within 2 hours after a single 250-mg dose and it can be detected in the stratum corneum 24 hours after oral administration. It is also detected in the hair and distal nails within 1 week of starting therapy at a dose of 250 mg/day. The most common side effects include burning, stinging, dryness,

erythema, itching, local irritation, and, rarely, allergic reactions. Terbinafine undergoes extensive metabolism in the liver. When compared with azoles, terbinafine has affinity for less than 5% of CYP enzymes, giving it a relatively low potential for affecting the metabolism of other drugs. Nevertheless, terbinafine is a potent inhibitor of CYP2D6 and affects drugs that are predominantly metabolized by this enzyme, such as tricyclic antidepressants, β -blockers, some selective serotonin reuptake inhibitors, and monoamine oxidase inhibitors type B. Terbinafine decreases the clearance of caffeine by 19% and increases the clearance of cyclosporine by 15%.

Azole antifungals are divided into the imidazoles (miconazole and ketoconazole) and the triazoles (itraconazole, fluconazole, voriconazole). The latter group has three instead of two nitrogen atoms in the azole ring, all of the azoles operate via a common mode of action: they prevent the synthesis of ergosterol, the major sterol component of fungal plasma membranes, through inhibition of the fungal cytochrome P450-dependent enzyme lanosterol $14-\alpha$ -demethylase. The resulting depletion of ergosterol and the concomitant accumulation of 14-amethylated precursors interferes with the bulk function of ergosterol in fungal membranes and alters both the fluidity of the membrane and the activity of several membrane-bound enzymes (chitin synthase)¹⁸. The net effect is an inhibition of fungal growth and replication with a number of secondary effects, such as inhibition of the morphogenetic transformation of yeasts to the mycelial form, decreased fungal adherence, and direct toxic effects on membrane phospholipids, also being reported. Unfortunately, as a result of the nonselective nature of the therapeutic target, cross-inhibition of P450-dependent enzymes involved in human liver function has been responsible for some toxicity, although significantly lower and less severe with the triazoles than with the imidazoles. Note that the mechanism here is not that different than the allylamine mechanism of action, for patients with long-term fungal colonization, alternating these agents often provides a better outcome and less liver toxicity. So many of our botanical medicines work a lot better than these do, especially topically applied salves.

Salves are generally made from an oil base that is thickened with a wax, like beeswax. One can start with an herbal oil infusion, warm it in a double boiler, and slowly add small pieces of wax on the order of 1 part beeswax for every 8 parts oil. More wax makes a thicker salve and less wax makes more of an ointment. An excellent method for making quick salves is to add essential oils to the warm oil and melted beeswax just prior to pouring into the salve containers. We usually use 1-2 tsp. (5-10 ml) of total essential oil per ounce of salve; an excellent antifungal salve is ½ tsp each of oregano and thyme essential oils per ounce of final product. If you don't end up using essential oils in the salve, it is a good idea to make sure that the oil base contains adequate Vitamin E oil (10% of total oil volume) to

prolong the shelf life of your product. Other options for this kind of approach include adding antifungal resins, we use pinon pine salve (*Pinus edulis*) and brittlebush (*Encelia farinosa*) resin...essentially, while the oil portion is heating in the double boiler you also add some resin--I find that a 5-10% resin content works very well as an antifungal.

Brittlebush (Encelia farinosa) is a medium-size shrub with oval, silver-gray leaves covered in tiny, fuzzy hairs. In the late winter and early spring, this Aster family plant produces beautiful yellow flowers on stems extending above the shrub. It is found throughout the Sonoran Desert and in the warmer areas of the Mojave Desert. Its common name is derived from its fragile and breakable stems, which is also how the plant spreads asexually. The O'odham and Seri natives used the viscous and transparent yellow resin to haft sharp points on arrows and fishing spears and as a sealant for their pottery containers. Encelia is regarded as a medicinal plant by the Seri, O'Odham and Cahuilla people. The branches can be cooked down to ashes to produce a gummy glue that can be applied to a loose tooth for support. The Cahuilla would also apply this gummy resin to their chest and joints to relieve pain. Early Spanish missionaries enjoyed burning the resinous crystals that exude from the stems. They liked the smell and regarded this plant as a form of incense. For this reason, the Spanish settlers in California called this shrub, 'incienso.' I find that 10% Encelia resin makes for a pretty effective antifungal when placed in a salve base, it works even better if we also add about 10% Creosote (Larrea tridentata) to the preparation...and the salve smells amazingly like a rainy day in the desert, and maybe, just maybe, one's feet can smell the same.

Monolaurin (glycerol monolaurate or GML) is the monoester formed from glycerol and lauric acid. Lauric acid is a naturally occurring 12-carbon mediumchain saturated fatty acid. The richest dietary source of GML is coconut oil but it is also found in human breast milk and palm kernel oil. The body has the ability to convert lauric acid into GML by enzymatic activity, it is not known how much this process actually occurs in vivo. Chemically, GML is a surfactant, it has been used for decades as a dispersant and emulsifier in the cosmetics industry and food industry. The antimicrobial activity of fatty acids and their esters is well known, with chain length, unsaturation (cis, trans), and functional groups all being variables that affect this activity. GML antimicrobial activity appears to be primarily by disruption of lipid bilayers, being up to 200 times more effective than lauric acid alone. Monolaurin first became available as a nutritional formulation in the mid-1960s and has some impact on mocrobial growth in the body, I find it a decent anti-fungal that doesn't create liver issues for most people.¹⁹ Orally dosed at 1 gm, 1/4 tsp, twice a day.

Changing the ecology of the foot and shoe can be profound, the addition of a tablespoon or so of baking soda to the shoes every two weeks or so helps reduce

foot odor and the level of fungal presence, it is not great for shoes that begin to exhibit a white crystalline structure on the outside of the shoe...which washes away. Spending more time with one's feet not confined to the sweaty interior of a heavy shoe is also very helpful.

Modern footwear is not very conducive to healthy feet for several reasons. Consider that one lesson to be learned from the ancient Chinese foot-binding practice is that feet can and will conform themselves to all kinds of crazy conditions. Many of the structural issues that we will discuss in foot pathology can be directly related to footwear, what we do to our feet every day is what our feet will adapt to, every day. The good news about this aspect of our developmental anatomy is that structural defects can also be changed with consistently applied support and strategic pressure distribution. If we could magically make everything in a body invisible except the collagen network, we would see dense leathery mesh in the bones, cartilage, tendons, and ligaments. We would see a very loose fascial mesh in the breast, the cheek, and the pancreas. Each muscle would be surrounded and invested with a looser (but still structurally strong) fascial network. Every bone would have a tough plastic-like fascial wrap layered around the outside. Every organ would be invested and then bagged in a sack of fascia. Only the open tubes of the digestive, respiratory, and lymphatic system would be relatively free of this fascial net, that is really one giant membrane. It is a neuro-myofascial web that acts as a whole and serves us from second-to-second within gravity and the other forces surrounding and affecting us, it is also vastly communicative, detecting and transmitting sensory information from the surrounding environment and facilitating a movement of internally derived communication in response to the constant input from the external world. Structure without function is a corpse. But function without structure is a ghost. Fascia is part of a vastly complicated architecture that follows different rules than the human made architecture that we are accustomed to observing; fascia responds locally and systemically, and to understand this systemic response at its most basic level, we invoke a concept known as tensegrity, a structural geometry that best describes the dynamic architecture of the human body.

Tensegrity is a word coined by Buckminster Fuller in the 1960's as a combination of 'tension' and 'integrity', after seeing the highly original sculptures of Kenneth Snelson, to indicate a structural integrity derived from the balance of tension between the elements of a system, not through compression forces. Biotensegrity, a term coined by the orthopedic surgeon, Dr. Stephen Levin, is the application of tensegrity principles to biologic structures, including muscles, tendons, ligaments, bones, fascia, and even into the fundamental building blocks of life, cell membranes and the microscopic cytoskeletal elements. The human musculo-skeletal system is a synergy of connective tissues from microscopic

elements to macroscopic anatomy. Superficially, the muscles and other softer connective tissues provide continuous tension, and the bones represent the discontinuous compression elements, the whole system is made exponentially stronger and more flexible by the coordinated efforts of these tensioned and compressed parts. Fascial continuity suggests that the myofascia acts like an adjustable tensegrity around the skeleton, from the fascia connected to the inner aspects of the skull to the plantar fascia in the soles of the feet – a continuous inward pulling elastic tensional network, with the bones acting like the struts in a tensegrity model, pushing against the stabilizing elastic bands²⁰. If any part of this system becomes deformed or distorted, relative to the whole network, innumerable, tiny, compensatory changes take place to ensure that the entire body remains posturally stable. Slow and intentional alterations in the anatomy, as we see in serial casting, therapeutic injections and certain kinds of therapy, allow for an efficient enough compensation on the part of the rest of the network that symptoms like pain only occur after significant tissue remodeling has taken place. Acute injury seldom allows adequate time for compensation and presents with rapid onset of pain. Pain is a vast subject that we will address later in this discussion, but, right now, we can recognize that the subjective experience of pain often plays a very significant role in the tissue remodeling process. If holding a particular position creates the experience of pain, one tends not to hold that position, and, over time, there is a certain reduction in the ways that a body can comfortably 'hold itself', which then impacts the ability of the body to perform certain activities potentially relevant to daily life. We understand some of the underlying mechanisms that are involved in this endless compensating network through the work of two physicians from the 1800's, Wolff and Davis.

Julius Wolff (1836–1902) was a German anatomist and surgeon who recognized that bones in a healthy person or animal will adapt to the loads under which it is placed. If loading on a particular bone increases, the bone will remodel itself over time to become stronger to accommodate that type of loading. What he clarified was that the internal bony architecture of the trabeculae adapts first, followed by secondary changes to the external cortical portion of the bone, becoming thicker or thinner, more or less dense to accommodate changing structural forces. It is really important to note that if the loading on a bone decreases, the bone will become less dense and weaker due to the lack of the stimulus required for continued remodeling²¹. Henry Gassett Davis (1807-1896) received his MD from Yale and became an orthopedic surgeon after growing up with a sister who had a difficult case of scoliosis during childhood. He founded the "traction" school of orthopedic surgery, created the first splint for traction and protection of the hip joint, and is known for his work in studying soft tissue adaptation. His findings on soft tissue remodeling paralleled Wolff's ideas on bone remodeling in that he proposed the idea that soft tissues heal according to the manner in which they are mechanically stressed:

"Ligaments, or any soft tissue, when put under even a moderate degree of tension, if that tension is unremitting, will elongate by the addition of new material; on the contrary, when ligaments, or rather soft tissues, remain uninterruptedly in a loose or lax state, they will gradually shorten, as the effete material is removed, until they come to maintain the same relation to the bony structures with which they are united that they did before their shortening. Nature never wastes her time and material in maintaining a muscle or ligament at its original length when the distance between their points of origin and insertion is for any considerable time, without interruption, shortened"

Henry Gassett Davis, "Conservative Surgery" Appleton & Co., NY, 1867²¹.

The fascial structure responds to changes in mechanical loading. Fundamental mechanical properties adapt over long periods of use/disuse as a result of biochemically mediated micro-structural changes at the level of the collagen fibers. Tissues that have lost their original strength due to extended periods of inactivity can regain most of their mechanical properties through gradual and consistent re-loading over a 6 to 8-week period of time. However, excessive loading during the recovery process may lead to material failure, i.e. tearing of fibers, rupturing of membranes. Too often, the pattern that the people that I see fall into is that they have long periods of time with relative inactivity, then spurious bouts of exercise and they get injured because they are exceeding the physical capacity of the involved tissues, new injury causes another reduction in activity, with further atrophy of the uninjured structures, so that, once full activity resumes, something else is injured or recovering. They might ride this roller coaster of activity/injury for years before they acquiesce into a full-time sedentary existence. We accommodate to the most comfortable existence that we can, if we aren't intentionally pushing our physical boundaries and maintaining a high level of free and painless movement, we are allowing the encroaching physical limitations of age to reduce the breadth of life that we get to experience in a painfree manner. There are metabolic ramifications to this situation that are far reaching and include diabetes and heart disease, the deadliest diseases in our country, and products of a sedentary lifestyle. The greater point is that the physical body is constantly remodeling itself to best suit the presenting situations of life. We can be too sedentary and lose the ability to be more vigorous in life, or we can be constantly overloading and injury prone. The body can shift and adapt immeasurably, given enough time and the right resources, we can teach/train a body to do just about anything we desire.

Serial casting is a medical technique that utilizes a series of casts to gradually stretch and realign muscles and soft tissues, often to improve range of motion and reduce muscle tightness. Davis's Law, which states that soft tissues model along the lines of stress, describes how serial casting works. By applying a series of casts that progressively stretch the tissues, serial casting leverages Davis's Law to encourage soft tissue adaptation and remodeling. There are a number of tools that are beneficial while engaged with serial casting processes, our clinic offers ultrasound guided injections of hyaluronidase and collagenase, to help breakdown scar tissue and lengthen shortened structures, we also provide PRP, platelet rich plasma, which helps shorten structures that are too lax. There are a number of items that we will include in those injections and other measures that we will apply as well, including Extracorporeal Shockwave Therapy (ESWT), a noninvasive form of treatment that was developed from ESWL (extracorporeal shock wave lithotripsy) and is based on a unique set of pressure waves that break down fibrous scar tissue, stimulate metabolism, enhance blood circulation and accelerate the healing $process^{22}$.

Serial casting can serve as a critical intervention for conditions that impair movement and muscle control such as cerebral palsy, spina bifida, and muscular dystrophy. Serial casting can help preserve mobility and delay the progression of atrophy while stretching contracted muscles and reducing spasticity, helping to improve range of motion and prevent further deformities in the affected limbs. It is also a type of foot-binding and part of our job is to make it as comfortable as possible, and hard, heavy cast material is not comfortable. There are less cumbersome options, and they are well worth considering; Turtle Brace is a company that makes a wide range of heat moldable bracing/casting materials, and they install a zipper for easy removal. You can mold and remold the material an absurd number of times and it still works--unless you get it too hot. Progressive Gaitways/Billi Cusick in Telluride, Colorado is a phenomenal resource for training in serial casting, they have introductory videos on their website, and they sell the turtle braces²³. If you have any interest in this domain of medicine, please explore what Billi has to offer, she is brilliant and her training program is superb.

Stress and tension are many times related to one another; as we feel "stressed" we tend to become more tense. We then tend to hold our tension in particular areas of our physical body—many of us in our neck and shoulders, others in the thoracic or lumbar spine areas. One of the basic conceptions of muscle physiology is that it takes energy to relax a muscle. The blood flow into and out of a muscle is what allows delivery of energetic molecules into the muscle tissue, allowing for a relaxation response; this is one of the reasons why, when a body dies, every muscle ends up contracting and the body assumes Rigor Mortis. Ironically, as a muscle contracts it literally "wrings" the blood out of itself, relaxation allows better blood flow back into the structure. Progressive tension in a muscle compromises its own blood flow which, then, causes more tension, often leading to a cycle of spasticity that can be difficult to break up. The longer a tissue stays spastic, the more likely they are to develop fibrous bands of scar tissue in muscles that are depriving themselves of blood flow, and the sensation of pain creates an additional tension in the surrounding region. The repeated contraction/relaxation cycle involved in a regular exercise regimen can be profoundly effective in re-establishing appropriate blood flow into spastic muscular structures. Well placed shockwave therapy, massage, hydrotherapy, therapeutic exercise and a topical agent to improve blood flow into and out of the area that is remodeling can be very helpful and might represent a base of intervention for many foot problems.

Creams are essentially botanicals mixed into a cream base. There are many bases available and there are both water and fat-soluble forms. An excellent lipophilic cream base can be made from whipped safflower or sunflower oil. For a hydrophilic cream base we use a cetearyl alcohol to emulsify beeswax and macadamia nut oil . Hydrophilic creams are fun and easy to make, I usually custom make them for specific patient problems, most of the time for musculoskeletal and neurological pain syndromes. We start with a base of 1 liter of macadamia nut oil, make it hot, I like a double boiler, add 300 gms of beeswax and 175 gms of emulsifying wax (cetearyl alcohol). I have had wonderful successes with peripheral neuropathy and CRPS (complex regional pain syndrome) with the following cream recipe:

- 1 oz. Aconitum napellus tincture
- 1 oz. Veratrum viride tincture
- 1 oz. DMSO

Mix into 100 gms cream base very slowly while stirring with a wooden tongue depressor.

Aconitum napellus-Monkshood is abundant in the mountainous woodlands of various parts of Europe, Asia, and North America, especially along the Pyrenees in France, the Himalayas, and throughout Siberia. It is a high altitude plant, growing at heights of 10,000 to 16,000 feet. The medicinal part is considered to be the root. This is one of the most toxic botanicals that are still present in the formulary of botanical medicine. It has proven itself of great enough value that it is still present in modern clinical practice. Even so, I can't emphasize enough that this one of those low dose botanicals, even for topical use. This plant contains several di-ester alkaloids, including aconitine, mesaconitine, hypaconitine, Ndesethyl aconitine, and oxoaconitine. These compounds increase the membrane polarity of nerve cells for sodium ions and slow repolarization of the nerve. The details of this process are a source of fascination for me. Recall that the ability of a

nerve cell to create a charge across its membranes is essential to its role of transmitting electrical current through the nerve itself. The formation of the charge is dependent on sodium/potassium pumps being able to pump sodium to the outside of the cell, creating a relative positive charge on the outside of the nerve and a relative negative charge on the inside. When a current is passed through the nerve, voltage gated sodium channels open up and the sodium floods into the cell, releasing electrical energy that perpetuates the signal that is being sent. After the current has passed, the body begins to set up the same electrical gradient across the membrane for the next time that an action potential is needed. When the di-ester alkaloids in Aconite are present, the membrane becomes more permeable to sodium ions, initially this has a stimulating effect, the sodium is rushing into the cell as if there were a message being sent and a depolarization of the membrane occurs. When the action potential has been fired, the nerve would normally begin to repolarize the membrane by pushing sodium back out of the cell but, because the cell membrane is now more permeable to sodium, they just slip back inside and the cell can't repolarize. This has the practical effect of paralyzing/anesthetizing that nerve if it is a sensory nerve, which can be great for neuralgias and neuropathies. It has the problematic effect of doing the same thing to the vagus nerve and the cardiac innervation when it is in too great an amount in the system and that can kill a person²⁴.

Veratrum viride-Green Hellebore is a plant that was much revered by the eclectics at the turn of the century, they literally wrote volumes about it. It contains several steroidal alkaloids, including some solanidanes, isorubijervine, rubijervine, germitrin, veratrine and protoveratrine. Maude Grieve feels that because of its potential toxicity, its only justifiable use is as a topical an anodyne counterirritant, especially for neuralgias. Ellingwood reports the first signs of poisoning to be sneezing, lacrimation, salivation, vomiting, diarrhea, burning of the mouth and throat, and hypotension. This herb provides a consistent reduction of blood pressure and slowing of the pulse, this is thought to be primarily due to the action of the alkaloid germitrin²⁵. It is also indicated for topical use as a local anesthetic and counterirritant. I have used this herb topically for neuropathies, neuralgias and sciatica, often mixed into a liniment or a cream with equal parts of aconite, lobelia and DMSO, ten to twenty drops applied to the area. I have yet to see anyone get a toxic effect from this plant. With careful dosing and conscientious prescribing, it can be a wonderful adjunctive botanical agent.

Topically applied tropane alkaloids can be very helpful in spastic conditions as is Capsicum, not just as a source of pan relieving capsaicin, but also because it helps improve blood flow. Agents that we find helpful to include for those going through serial casting and struggling with spasticity include, Datura, Atropa, Capsicum, Lobelia as well as Piroxicam (as an anti-inflammatory), Pentoxifylline (a blood flow agent) and Baclofen (a topical anti-spasmodic).

Atropa belladonna-Deadly Nightshade lives in the shadowy recesses of our culture, even people who have no knowledge of botanical medicine have heard about this one, usually in the context of scary things that can kill you. We find the earliest human usage of Atropa belladonna as seeds in the living and ritually used areas of a village dated to 4500 BCE in Romania. It is probably the most famous of the "witches' herbs" and has a tremendous amount of European folklore associated with it. Maude Grieve reminds us that according to old legends, the plant belongs to the devil who goes about trimming and tending it in his leisure and can only be diverted from its care on one night in the year, Walpurgis, when he is preparing for the Witches' Sabbath. The apples of Sodom were thought to be related to this plant and the name Belladonna is given to it because at certain times it takes the form of an enchantress of exceeding loveliness, whom it is dangerous to look upon. It is more likely that the name derived from the use of the juice of the plant by Italian ladies to give their eyes greater brilliance by dilating them²⁶. Ophthalmologists use the alkaloid atropine, originally derived from this plant, to perform a similar function today. The thing about legendary plants with reputations as poisons is that they tend to freak people out, especially insurance agents trying to parse out malpractice insurance needs so that the medical school can continue to send students to your clinic for off-site training. Yet, this has been one of the most useful medicinal plant allies that humans have ever employed and indispensable for my botanical medicine practice, it is no exaggeration to say that we use this plant and its botanical cousins on a daily basis in our clinic.

The leaf and the root of this plant are used medicinally; the different plant parts have slightly different alkaloids with varying qualities, leaf and root are more consistent and predictable in concentration. The chief alkaloid throughout the plant is L-hyoscyamine, which transforms to some degree into atropine (a racemic mixture-D, L-hyoscyamine) with drying. Also present are other tropane alkaloids like apoatropine, scopolamine, and tropine. The tropane alkaloids are competitive antagonists of the neurotransmitter acetylcholine, the original anticholinergics (even though the receptors are named after muscarine--fungal politics, they always win in the end). Essentially these compounds bind to the same receptor as acetylcholine, keeping that neurotransmitter from doing its job while exerting an opposite effect at the receptor. This effect is limited to the muscarinic receptors, not so much to the nicotinic receptors. What this means from a practical clinical perspective is that this plant is a specific antispasmodic and sometimes perfect for tight and sore muscles when rubbed in topically. Fibromyalgia patients do quite well with such application, as do patients with dystonia from neurologic injury. Felter refers to it as a remedy of power in the acute congestion of the kidneys, for

this he recommends external application with a poultice over the kidneys as well as internal dosing²⁷. King's American Dispensatory gives us, perhaps, the best summation of belladonna toxicity, in large doses it acts upon the cerebrospinal system with a dilation of the pupils, far-sightedness with obscurity of vision leading to absolute blindness, visual illusions (especially of phantasms), ringing in the ears, numbness of the face, giddiness and delirium. The mouth and throat become dry with difficulty in swallowing and articulating, constriction about the throat, nausea, vomiting, swelling, and redness of the skin²⁸.

The genus *Datura* (Solanaceae) contains nine species of medicinal plants that have held both therapeutic effect and cultural significance throughout history. Although Datura contains mostly tropane alkaloids (such as hyoscyamine and scopolamine), indole, beta-carboline, and pyrrolidine alkaloids have also been identified. *Datura* is known as the Holy Flower of the North Star by the Chinese because of a Taoist legend that maintains that *Datura metel* is one of the circumpolar stars and that envoys to earth from this star carry a flower of the plant in their hand. Throughout the entire world, Datura has had a long history as a medicine and sacred hallucinogen. Like belladonna, it owes much of its physiologic potency to the presence of the tropane alkaloids hyoscyamine, atropine, and scopolamine. It shares anticholinergic and parasympatholytic effects with belladonna. Maude Grieve, in her classic text on botanical medicine, writes that Datura is employed in all of the conditions for which belladonna is more commonly used, but acts much more strongly on the respiratory organs. It has a special reputation as an effective agent for spasmodic asthma²⁶.

Many indigenous people use Datura for its visionary properties, valuing it for diagnosis, healing and intoxication. Upon learning from these visions the cause of a particular disease, a proper prescription can be applied to the case. The Chinese herbalist Li Shih-Chen, in 1596, writes, "According to traditions, it is alleged that when the flowers are picked for use with wine while one is laughing, the wine will cause one to produce laughing movements; and when the flowers are picked while one is dancing, the wine will cause dancing movements. I have found out that such movements will be produced when one becomes half-drunk with the wine and someone else laughs or dances to induce these actions." The Aztecs knew the species D. stramonium and D. innoxia and named them as "Tlapatl" and "Mixitl," respectively, the flowers and the seeds of the plant were used externally for the treatment of skin rash of the face and orally ingested for the treatment of neurological conditions. It is an important anesthetic when consumed along with cannabis in wine²⁹. The earliest documentable human uses of Datura occur as debris in pottery samples from Western Mexico dated to 1400 BCE and to 1600 BCE from hair samples recovered from the Es Carritx burial site on the island of Menorca, Spain³⁰.

Capsaicin (trans-8-methyl-N-vanillyl-6-nonenamide), is a fat-soluble, oily substance derived from *Capsicum spp*, pepper plants, and has been used in traditional medicine for centuries to treat pain. Topical application of capsaicin creates an initial burning sensation as it binds to a highly selective vanilloid receptor subtype 1 (TRPV1), a non-selective cation channel that responds to noxious stimuli such as pH extremes, temperature extremes and chemical irritants. The neuropeptide substance P (SP) is expressed in primary sensory neurons and is commonly regarded as a "pain" neurotransmitter as it activates the neurokinin-1 (NK-1) receptor and potentiates activity of vanilloid receptor subtype 1 (TRPV1), which is co-expressed by nociceptive neurons. SP functions as an important neurotransmitter involved in the hypersensitization of inflammatory pain, using it up through repeated local applications of capsaicin prevents the local pain stimuli from reaching the brain. In the area of application, tissue sensitivity to pain decreases, and the pain threshold increases. Several studies have focused on the use of capsaicin as a topical analgesic for pain that is not responsive to traditional painkillers, such as non-steroidal anti-inflammatory drugs (NSAIDs), opiates, and paracetamol. Topical capsaicin has a proven effectiveness in the treatment of chronic pain conditions, including rheumatological diseases and diabetic peripheral neuropathy, it also acts as a counter-irritant, facilitating delivery of other agents in a topical application.

Piroxicam is a nonsteroidal, anti-inflammatory, and analgesic agent. It is a fat-soluble agent that creates an analgesic/anti-inflammatory effect by inhibiting the cyclooxygenase (COX) family of enzymes. It is able to made into a topical preparation which improves specificity of application over oral dosing and reduces the frequency of harmful adverse gastrointestinal events. The direct application of piroxicam and capsaicin to a painful area reduces the amount of active drug passing into the systemic circulation, thus facilitating safer analgesic treatment without systemic effects. Such therapies are very useful for the treatment of direct trauma, especially superficial pain resulting from events such as sprain, strain, muscle injury, and tendon trauma. NSAID use has a destructive impact on cartilage regeneration by inhibition glycosaminoglycan synthesis, so also contribute to drier joints. A notable exception in this class of medications is piroxicam, it has proven to have no detrimental effect on cartilage metabolism³¹, it is a convenient addition to a topical cream at doses of 1-3%.

Pentoxifylline is a methylxanthine derivative conventionally used for the treatment of intermittent claudication, it is a vasoactive agent, increasing tissue perfusion of blood via several mechanisms of action such as increasing erythrocyte and leukocyte elasticity, preventing platelet aggregation, and providing a vasodilatory effect. It also has anti-inflammatory and antioxidant properties.

This agent is really useful topically for the treatment of pressure injury. Several studies have shown that topical pentoxifylline could prevent pressure injury, reduce the severity of existing injury, or accelerate the wound healing process³². I find this a useful addition, on the order of 3% in a topical cream for use in between casting sessions for those doing serial casting, the pentoxifylline toughens the skin and prevents some of the pressure injury that can become problematic for future casting applications

Baclofen Baclofen (β -parachlorophenyl GABA), is a GABA-B agonist that acts as a muscle relaxer and an antispasmodic agent that inhibits spinal reflexes, reducing spasticity and improving both passive and active movement. Baclofen is used to treat muscle pain, spasms, and stiffness in people with multiple sclerosis or spinal cord injury or disease. Baclofen is given intrathecally (directly into the spinal cord), orally and applied topically. Side effects include ataxia, central nervous system depression and seizures. The initiating dose is 2.5-5 mg/day which can often rise to the higher doses of 20-60 mg/day depending on age and size. Baclofen must be weaned slowly to avoid withdrawal symptoms, which include seizures, irritability, increased spasticity, and mental confusion. I find that a 10% reduction of the current dosage every 4-7 days is a tolerable weaning schedule for most. Topical baclofen, applied as a 3% concentration in a cream that will also contain tropane alkaloids, does work somewhat as a local muscle relaxer, we use it as such 2-3 times a day.

Amanita muscaria, the fly agaric, is a relatively small 'gill-bearing' toadstool, growing to between 5 -12cm tall. Early in its fruiting, it is covered by a white membranous veil, which tends to rip as the stem pushes up and the bright red cap expands. The remains of the veil skirt the stem and also leave white, wart-like flakes covering the cap, though these are sometimes washed away by heavy rain. As it matures, the cap opens up like an umbrella, forming a depression around the center. Its red skin can easily be peeled off. The stem is bulbous at the base and discontinuous with the cap. The mushroom flesh is white and has no particular smell when fresh. Upon drying it develops an unpleasant musky-acrid smell, which erroneously has been claimed to ward off flies. In North America a closely related species, *A. americana* is also referred to as Fly Agaric. Its' cap tends to be more yellow-orange. Less similar and more toxic in nature is *A. pantherina*, whose cap tends to be more yellow-brownish and its stem more slender. All these species are generally regarded as poisonous and even deadly.

In the mid-1960's the entheogenic compounds of Amanita muscaria were positively identified as ibotenic acid and muscimol, its decarboxylized derivative. Research concluded that the actual psychotropic effect is most likely produced by muscimol, since 50-100 mg of ibotenic acid produces the same effects as 10-15 mg of muscimol. The symptoms of inebriation are characterized by muscle twitching, dizziness, visual distortions (macropsia and micropsia) and altered auditory perception. The potency of individual mushrooms tends to vary widely, their power being modified by environmental factors, such as seasonal variation, the weather, the phase of the moon and the pH level of the soil. The Kamchatcals from northern Siberia, who have a long history of Fly Agaric use, maintain that those that desiccate while still in the earth and remain attached to the stalk tend to have a greater psychotropic effect than those that are picked fresh and strung up to dry. They also claim that the smaller ones, whose bright red caps are still covered with many white spots, are said to be stronger than the larger ones with paler caps and fewer spots. Those picked in August are said to be the strongest. For topical use, it is made into a 1:3 tincture and applied topically on the order of 2-3 drops to an area in pain, or, more commonly, added to a lotion or pain cream. Using the basic recipe for a topical cream outlined above, the added tincture preparation might look like:

1 oz. Lobelia acetract

1 oz Amanita muscaria tincture

- 1 oz Atropa belladonna tincture
- 1 oz DMSO

The Amanita is specific for swollen, inflamed nerves, like an irritated sciatic nerve, peripheral neuropathy or neuralgia³³. I have seen it work very rapidly to bring relief that wasn't forthcoming by other means.

Plantar fasciitis is the most common cause of heel pain presenting in the outpatient setting. Estimates show that approximately 1 million patient visits annually are due to plantar fasciitis and this condition accounts for about 10% of runner-related injuries and 11% to 15% of all foot symptoms requiring professional medical care. Plantar fasciitis occurs in about 10% of the general population, with 83% of these patients being active working adults between 25 and 65 years. The peak incidence is among the general population of 40 to 60 years. Plantar fasciitis may present bilaterally in a third of the cases. In addition, a higher prevalence of plantar fasciitis was observed in women compared to men, in those aged 45 to 64 versus those aged 18 to 44, and in those with a body mass index >25 kg/m². Some literature shows that runners' prevalence rates are as high as 22%. Plantar Fasciitis presents as inflammation on the bottom of the foot that leads to heel and/or arch pain. A variety of foot injuries or improper foot mechanics can lead to plantar fasciitis. Treatments range from icing and foot exercises to the prescription of dynamic orthotics to correct the foot position and help alleviate pain. Specifically, we address the patient's gait, their footwear, and their baseline level of inflammation. A cream consisting of Capsicum/Datura/Lobelia and DMSO can be additionally loaded with 2% piroxicam, and 3% Pentoxifylline and applied to the affected foot twice a day and will reduce the inflammatory cascade, reduce the pain

and get better blood flow into and out of the sole of the foot. In many cases, the strain/sprain pattern in the foot has been an extension of the distance from the ball of the foot and the heel, the common phrase, "fallen arches", is not necessarily appropriate but the process is the same. As the tension in the fascial band, which extends into all five metatarso-phalangeal joints and then consolidates at the inside of the calcaneus (heel), increases, the fascia becomes overstretched and damaged, it is not uncommon to have heel spurs develop at the attachment of the plantar fascia with the heel. A dynamic orthotic can be very helpful--this is not a custom, static orthotic, this is a platform that approximates the arch of a foot and compresses down with each step and then recoils back to its original shape after, it works the muscles of the feet and ankle in a way that allows a reconstitution of the falling arch. Extracorporeal shockwave therapy is really a great intervention for this condition, providing pretty rapid relief. Plantar fascitis also responds to hydrotherapy, the affected limb can be treated with alternating hot and cold baths, 1 minute cold and 4 minutes hot with 4-10 alternations--start with not-so-hot and not-so-cold for only a few alterations until one gets used to the increase in blood flow and gradually increase the temperature differential and number of alternations. Wet sock-type of warming compresses are also very helpful, usually applied before bed, a loose-fitting cotton sock is made damp and placed on the affected limb, a loose wool sock is placed over the top of the damp cotton sock. As the patient sleeps, the body tries to dry the moisture and increases blood flow into and out of the region, which generally reduces pain and swelling while allowing the fascia to recover. Heel spurs are growths of bone on the underside, forepart of the heel bone. Heel spurs occur when the plantar tendon pulls at its attachment to the heel bone. This area of the heel later calcifies to form a spur, it is highly associated with a shifting arch and stretching of the plantar fascia. The shockwave can pulverize the spur, we do an ultrasound guided barbotage where we will identify the spur, treat the area with shockwave and then, under ultrasound guidance place a needle at the site and suck the debris into a syringe. It is very satisfying.

A bunion, or hallux valgus, can be seen as a failure of the metatarsal arch, specifically at the first metatarsal joint. When the arch collapses or weakens, it can lead to a misalignment of the big toe and the formation of a bunion. This misalignment puts increased pressure on the first metatarsophalangeal (MTP) joint, contributing to further development of the bunion and deterioration of the joint. Bunions do run in families, because foot type (shape and structure) is hereditary, and some types are more prone to bunions than others. Low arches, flat feet, and loose joints and tendons all increase the risk. The shape of the metatarsal

head also makes a difference: if it's too round, the joint is less stable and more likely to deform when squeezed into shoes with narrow toes. High heels can exacerbate the problem because they tip the body's weight forward, forcing the toes into the front of the shoe and may explain why bunions are 10 times more common in women than in men. People in occupations such as teaching and nursing, which involve a lot of standing and walking, are susceptible to bunions. So are ballet dancers, whose feet suffer severe repetitive stress. Women can develop bunions and other foot problems during pregnancy because hormonal changes loosen the ligaments and fascia and body weight increases precipitously. Ultimately, cowboy boots and high heels are primary causes of bunions. Surgery is frequently performed to correct the problem, however, surgery leaves scar tissue behind which becomes harder and more fibrous over time and can complicate the situation. There are a lot of similarities between the cause of plantar fasciitis and the cause of bunions, the plantar fascia is a response to the longitudinal stretching of the fascia that supports the major arch of the foot, in a bunion, there is a lateromedial stretch of the fascia of the metatarsal arch, allowing a migration of the first joint away from the other four. Structurally, the metatarsal arch needs to be supported so that the fascia can shrink back to a more normal tension, this means wearing the right kind of shoe, and possibly employing a dynamic orthotic, as mentioned earlier for plantar fasciitis. I really appreciate the movement toward barefoot shoes that has happened over the past two decades, assuming a person can get their foot into a pair of shoes that has a slot for each toe, they can be beyond helpful to reduce or reverse a bunion formation. At the very least, shoes should have a wide, flexible sole to support the foot and enough room in the toe box to accommodate the bunion. Some good choices are sandals, athletic shoes, and shoes made from soft leather. Shoes with a back should have a sturdy heel counter to keep the heel of the foot snugly in place. You may be able to reshape narrow shoes with stretchers that make room in the toe box for the bunion. Low to no heel is best. I generally talk to people about their footwear, a dynamic orthotic and some Kinesio-tape...if the can comfortably place a layer of K-tape around the bunion joint and the rest of the foot--not tight but enough to provide support so that the fascia is able to start shrinking, that will help over the long-run. Anti-inflammatory topical agents like the aforementioned creams with piroxicam and pentoxifylline

can be really helpful, alternating hot/cold foot baths, wet socks, oral dosing of Boswellia and Turmeric can also be very helpful.

Hammertoe is very often a manifestation of the same fascial stretching and tendinopathy related to heavy stressors placed on the feet without appropriate support...and to be fair, in many instances no support is better than ill-placed/illfitted support. Hammer toes tend to stem from muscle imbalance, tendon issues and fascial distortion and the toe is forced into a claw-like position. Hammertoe can affect any toe, but most frequently occurs to the second toe, especially when a bunion slants the big toe toward and under it. Selecting shoes and socks that do not cramp the toes may help alleviate pain and discomfort. Better foot support is often the key to hammer-toes, as is frequent hot/cold foot baths with epsom salts. Our clinic uses musculoskeletal ultrasound guided injections and, often, we can address fascial restrictions and tendinopathies very effectively with that tool. The measures that we discuss for plantar fasciitis and bunions is apropos here as it is really a different manifestation of the same pathology.

Ingrown toenails are those nails with corners or sides that dig painfully into the adjacent tissues of the toe. Ingrown toenails are usually caused by improper nail trimming, but can also result from shoe pressure, injury, fungal infection, heredity, and poor foot structure. Women are more likely to have ingrown toenails than men. The problem can be prevented by trimming toenails straight across, selecting proper shoe styles and sizes, and responding to foot pain in a timely manner. In acute situations, a V-notch can be cut into the offending nail and the sides will be drawn in while the nail growth shifts to cover the exposed bed.

Neuromas are enlarged benign growths of nerves that can occure anywhere in the body. Morton's neuroma is a particular type that occurs most commonly between the third and fourth toes of the feet and is caused by tissue rubbing against and irritating the nerves. Pressure from ill-fitting shoes or abnormal bone structure are common causes of this condition. It is highly associated with plantar fasciitis, bunions and hammer toes, also associated with bad foot wear and the breaking down of feet that lived their lives in a constraining box, this is the neurological manifestation of that breakdown. The topical applications previously discussed can be very helpful, as can ultrasound guided injections of PRP, Procaine, TB4 and collagenase.

Sulbutiamine, fursultiamine, and benfotiamine are fat soluble forms of thiamine (vitamin B1), they were developed in Japan in an effort to develop more clinically useful thiamine compounds. Thiamine is normally unable to diffuse across plasma membranes because it has a positively charged thiazole moiety, it must be actively transported across plasma membranes. Structurally, sulbutiamine and benfotiamine are derived from allyl-thiamine and consist of lipophilically modified thiamine molecules, which, allows them to cross the blood-brain barrier more readily than thiamine and increase the levels of thiamine and thiamine phosphate esters in the brain and peripheral nerves. Sulbutiamine and fursultiamine are some of the only truly effective compounds used to treat asthenia, mental fatigue commonly associated with neurologic injury and one of the most persistent quality of life issues in patients so afflicted, it appears to have a positive impact on memory, reduces psycho-behavioral inhibition, and improves erectile dysfunction. At therapeutic dosages, 30-50 mg/day for fursultiamine and 200 mg/day for sulbutiamine, there are few reported adverse effects. Benfotiamine is more specifically anti-inflammatory in the peripheral nervous system and is helpful in reducing the incidence of peripheral neuropathy, neuromas and speeding the healing of damaged nerves as in sciatica, MS, and tissue trauma. Dosages of 200-400 mg/day are usually effective.

Our feet are a precious appendage that, in the words of the Buddhist monk, Thich Naht Hahn, 'allow us to kiss the earth with every step', they are our source of 'grounding' and when they are pain free and working well, we are virtually unstoppable, when they are painful and not working well, we can hardly get to the bathroom. Few parts of us have more impact on our mobility and our sense of selfconfidence and competence than our feet.

References:

- 1. Macho, Gabriele. (2018). Referential Models for the Study of Hominin Evolution: How Many Do We Need?. 10.7551/mitpress/11032.003.0014.
- 2. Laitman JT. Evolution of the human foot: a multidisciplinary overview. Foot Ankle. 1983;3(6):301-304.
- 3. Morton DJ. The Human Foot: Its Evolution, Physiology, and Functional Disorders. New York: Columbia University Press; 1935.

- 4. Lake NC. The Foot. London: Bailliere, Tindall and Cox; 1935.
- 5. Ko, Dorothy. Cinderella's Sisters: A Revisionist History of Footbinding. University of California Press, 2005.
- 6. Li, Jing. Chinese Tales. In Donald Haase (ed.). The Greenwood Encyclopedia of Folktales and Fairy Tales. Vol. I: A-F. Greenwood Press;2008. p. 197.
- 7. Carruthers, Amelia. Cinderella And Other Girls Who Lost Their Slippers (Origins of Fairy Tales). Read Books; 24 September 2015.
- Andrew Lang, The Blue Fairy Book (London: Longmans, Green, and Co., ca. 1889), pp. 64-71.
- Charles Perrault, "Cendrillon, ou la petite pantoufle de verre," Histoires ou contes du temps passé, avec des moralités: Contes de ma mère l'Oye (Paris, 1697).
- 10. Althaus-Reid, Marcella MarÍa, 'Feetishism: The Scent of a Latin American Body Theology', in Virginia Burrus, and Catherine Keller (eds), Toward a Theology of Eros: Transfiguring Passion at the Limits of Discipline, Transdisciplinary Theological Colloquia (New York, NY, 2007; online edn, Fordham Scholarship Online, 10 Mar 2011).
- 11. Outen, Gemma. "The Women's Total Abstinence Union and periodical Wings, 1892-1910: a study of gender and politics." (2017).
- Fessler, D. M. T., Stieger, S., Asaridou, S. S., Bahia, U., Cravalho, M., de Barros, P., et al. Testing a postulated case of intersexual selection in humans: the role of foot size in judgments of physical attractiveness and age. Evolution and Human Behavior, 33, (2012);147–164.
- Patricia Buckley Ebrey. The Inner Quarters: Marriage and the Lives of Chinese Women in the Sung Period. University of California Press, (1993); pp. 37– 39.
- 14. Mazo, Joseph H.. "Dance Is A Contact Sport." Dance Research Journal 8 (1974): 23 24.
- 15. Carter, Keryn. Consuming the Ballerina: Feet, Fetishism and the Pointe Shoe. Australian Feminist Studies, 15, (2000);81-90.
- 16. Berkowtiz, Roger. translator of The Origin of the Work of Art, by Martin Heidegger, originally presented as a lecture on November 13, 1935 at the Kunstwissenschaftliche Gesellschaft in Freiburg. 2006 translation; pg. 17.

- 17. Birnbaum J. E. (1990). Pharmacology of the allylamines. Journal of the American Academy of Dermatology, 23(4 Pt 2), 782–785.
- J.A. Maertens. History of the development of azole derivatives. Clinical Microbiology and Infection; Volume 10, Supplement 1, 2004, Pages 1-10.
- 19. Lieberman S, Enig MG, Preuss HG. A review of monolaurin and lauric acid. Altern Complement Ther. 2006;12(6):310–314.
- 20. Swanson, RL (2013). "Biotensegrity: a unifying theory of biological architecture with applications to osteopathic practice, education, and research-a review and analysis". The Journal of the American Osteopathic Association. 113 (1): 34–52.
- 21. Ruff, Christopher & Holt, Brigitte & Trinkaus, Erik. (2006). Who's Afraid of the Big Bad Wolff?: "Wolff's Law" and Bone Functional Adaptation. American Journal of Physical Anthropology. 129. 484–498.
- 22. Auersperg V, Trieb K. Extracorporeal shock wave therapy: an update. EFORT Open Rev. 2020 Oct 26;5(10):584-592.
- 23. https://gaitways.com/pages/cusick-center-for-learning-on-demand-courses
- 24. Şuţan NA, Paunescu A, Topala C, Dobrescu C, Ponepal MC, Stegarus DIP, Soare LC, Tamaian R. Aconitine in Synergistic, Additive and Antagonistic Approaches. Toxins (Basel). 2024 Oct 27;16(11):460.
- 25. Chandler CM, McDougal OM. Medicinal history of North American Veratrum. Phytochem Rev. 2014 Sep;13(3):671-694.
- 26. Grieve, M, A Modern Herbal 1931, Reprinted by Dover Publications, NY, NY 1971.
- Felter, Harvey Wickes, The Eclectic Materia Medica, Pharmacology and Therapeutics 1922, Reprinted by Eclectic Medical Publications, Sandy, OR 1983.
- 28. Lloyd, John Uri. King's American Dispensatory. 1898 Reprinted by Eclectic Medical Publications, Sandy, OR 1983.
- 29. F.J. Carod-Artal. (2015) Hallucinogenic drugs in pre-Columbian Mesoamerican cultures. Neurología (English Edition) 30:1, pages 42-49.
- 30.Guerra-Doce, E., Rihuete-Herrada, C., Micó, R. et al. Direct evidence of the use of multiple drugs in Bronze Age Menorca (Western Mediterranean) from human hair analysis. Sci Rep 13, 4782 (2023).

- 31. Abdulkarim MF, Abdullah GZ, Chitneni M, Salman IM, Ameer OZ, Yam MF, Mahdi ES, Sattar MA, Basri M, Noor AM. Topical piroxicam in vitro release and in vivo anti-inflammatory and analgesic effects from palm oil estersbased nanocream. Int J Nanomedicine. 2010 Nov 4;5:915-24.
- 32. Najafi E, Ahmadi M, Mohammadi M, et al. Topical pentoxifylline for pressure ulcer treatment: a randomised, double-blind, placebo-controlled clinical trial. J Wound Care 2018;27:495–502.
- 33. Ramawad HA, Paridari P, Jabermoradi S, Gharin P, Toloui A, Safari S, Yousefifard M. Muscimol as a treatment for nerve injury-related neuropathic pain: a systematic review and meta-analysis of preclinical studies. Korean J Pain 2023;36:425-440.