

Filler in the foot: treatment of plantar fat pad atrophy with dermal fillers

Aesthetic medicine practitioners know that one of the quickest ways to add a degree of youthfulness to the human face is to revolumise the deep and superficial facial fat pads. This is fairly easy to accomplish with injections of dermal fillers such as hyaluronic acid (HA). Fortunately, the only real consequence of this facial fat pad atrophy is an aesthetic one: sagginess, hollowness and wrinkled skin. Jowls and facial rhytides are not painful and do not disrupt functionality of the mouth or face. Unfortunately, pain can be a significant issue when fat pads at weight-bearing surfaces of the body become thinned, and ambulation can be disrupted. Can this pain be relieved with injections to the fat pads to restore their cushioning properties and can it be performed like facial fillers?

Just as facial fat pads thin with age, plantar fat pads wear out too, likely faster because of the sheer amount of force to which the human foot is subjected (*Figure 1*). As the principle shock absorbers in the feet, over time, the plantar fat pads are less able to shield the metatarsals and calcaneus from the pressure of everyday standing and walking. In women, this fat pad depletion can be hastened by use of high-heeled shoes. In fact, several studies have demonstrated increased forefoot pain in high heel wearers (Snow et al, 1992; Borchgrevich et al, 2016). Women, who make up the vast majority of aesthetic patients, have also been documented to be the majority of patients seeking help for foot pain (Mannikko and Sahlman, 2017), with the bulk of these patients seeking help for metatarsalgia. It seems to make sense for aesthetic practitioners, who are already well versed in dermal fillers, to use their skill in injecting fillers to help alleviate pain. This is especially true considering that they are already injecting many of these patients' faces.

What is metatarsalgia?

Metatarsalgia is defined as pain in the forefoot under one or more metatarsal heads (Chanal, 2019). Most of the pressure during the toe-off phase of gait concentrates in this area (Mannikko and Sahlman, 2017), which accelerates forefoot fat pad atrophy. The heel fat pad acts as a shock absorber for

Abstract

A significant number of patients presenting to an aesthetics practice for anti-ageing treatments also have metatarsalgia secondary to age-related plantar fat pad atrophy. Injections of dermal filler into the plantar fat pads has been shown to relieve foot pain and revolumise the plantar fat pads, leading to an improved quality of life for patients. Aesthetic practitioners, with their knowledge of dermal fillers and injection skills, are ideally situated to help these patients. This article reviews the relationship between metatarsalgia and plantar fat pad atrophy and the history dermal filler injections to the plantar fat pads. Types of dermal fillers suited for plantar implantation, technique for injections and possible adverse events are also reviewed.

the calcaneus during the heel strike phase of gate (Chanda and McClain, 2019). Heel pain, which is often caused by plantar fasciitis, can also be secondary to bursitis and/or fat pad atrophy, and fat pad atrophy can precede plantar fasciitis (Gutteck, 2019). Increased body mass index (BMI), poor footwear choices, excessive weight-bearing exercise, such as long-distance running, and repeated corticosteroid injections to the area can all increase the risk for plantar fat pad atrophy and both heel and forefoot pain. Chronic disease such as diabetes and autoimmune connective tissue diseases can also increase the risk for developing plantar fat pad atrophy.

Treatment is typically conservative and aims to control the pain. Most often, stretching exercises, external padding, orthoses and non-steroidal anti-inflammatory drugs (NSAIDs) are prescribed and can be quite helpful. If pain continues or is intractable, surgical treatment, both soft tissue and bony, can be employed. Surgical treatment can include gastrocnemius muscle recession, metatarsal osteotomy and even excisional arthroplasty procedures (Chanal, 2019).

However, the mainstay of treatment continues to be an attempted external replication of the cushioning qualities of a healthy plantar fat pad. In the author's experience, patients soon tire of this approach, but cases are usually not severe enough to require a permanent surgical intervention. Patients complain of the bother of transferring prescription orthotics from shoe to shoe and/or wearing bulky padding (Boughton, 2017). They express a desire to walk barefoot,



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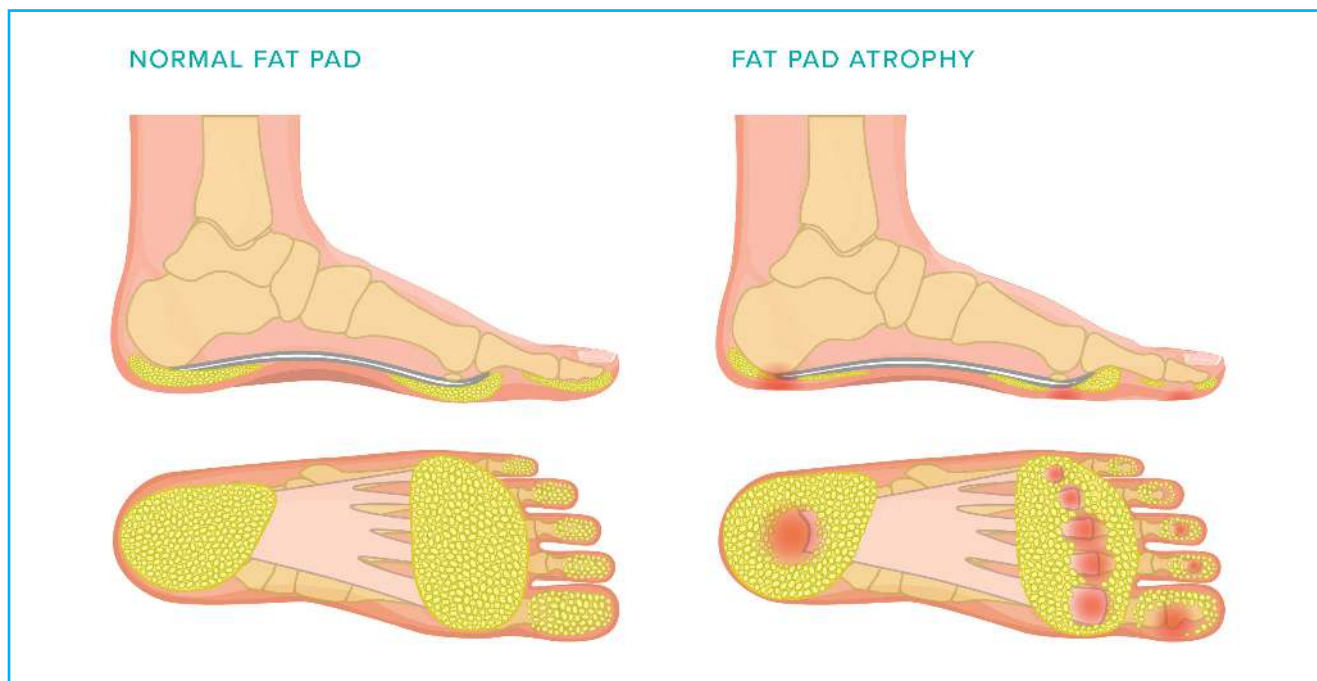


Figure 1. Foot fat pad atrophy

without pain, on the beach during vacation or a desire to wear fashionable flat shoes that cannot accept the volume of padding required for pain relief. Dermal filler injection to the plantar fat pads is a reasonable treatment option for these patients. By placing dermal filler directly in the fat pads, a thicker cushion is achieved, and the patient can carry around their own 'padding' internally. These injections are relatively easy for an experienced aesthetic injector, and the results are almost immediate. In the author's experience, patients have noticed pain relief as soon as the local anaesthetic wears off and the patient is ambulatory.

History of filler injections to the feet

Injections to volumise plantar fat pads is not a new idea, in fact, it has been around since the 1960s. Dr Sol Balkin is credited with being the first to use medical grade silicone as a filler in the plantar fat pads. In one of his publications, Dr Balkin noted that the idea came to him during a hospital staff lecture in 1963, at which a Dr Kagan was presenting findings of treatment with injectable silicone for breast augmentation (Balkin, 2005). Dr Kagan injected anywhere from 750 to 2000 cc to breasts, using something called the 'Sakurai fluid' (Balkin 2005). This was silicone fluid, possibly adulterated with olive oil to reduce scarring and fibrosis to keep the product from migrating (Chasan, 2007). This concoction was created by Dr Sakurai in Japan, who started injecting breasts in 1946 (Kagan, 1963). It is reported that at the end of World War Two, American quarter army masters noticed drums of the transformer insulation fluid (industrial grade silicone) disappearing from the docks of Yokohama

Port in Japan (Chasan, 2007). The silicone was being injected to prostitutes who sought a more 'western' appearance (Chasan, 2007).

After introduction to the US, possibly at the meeting that Dr Balkin attended, this type of breast augmentation became wildly popular. This is where the reputation of silicone takes a sharp downward descent. As with any fad treatment, the practice of injecting large amounts of silicone to the breasts was adopted by unscrupulous and untrained injectors. Practitioners began injecting everything from industrial grade silicone to bathroom caulking and caused disastrous consequences (DeLorenzi, 2012). The term silicone came to include all silicones, medical and industrial, and became synonymous with bad outcomes. As Narins and Beers (2006) put it, 'Despite the fact that proper and improper injections of silicone result in outcomes that are totally unrelated, many discussions of liquid silicone equate the horrific effects that occur after large volumes of contaminated or industrial grade silicone are used by unskilled individuals, with data garnered from injections performed by reputable physicians with decades of experience'.

Secondary to the poor reputation of silicone, attempts to revolumise the plantar fat pads with other types of dermal filler were tried. Predictably, collagen was a dismal failure, most likely a result of its short-lived viability in the human body. Dhinsa et al (2010) noted that collagen injection for metatarsalgia was unsuccessful. More recently, Founteaze et al (2018) used the hyaluronic acid Kysse, from Galderma, in the forefoot fat pads of 14 high heel-wearing female subjects in France. They were injected with an average of 1.3 ml of

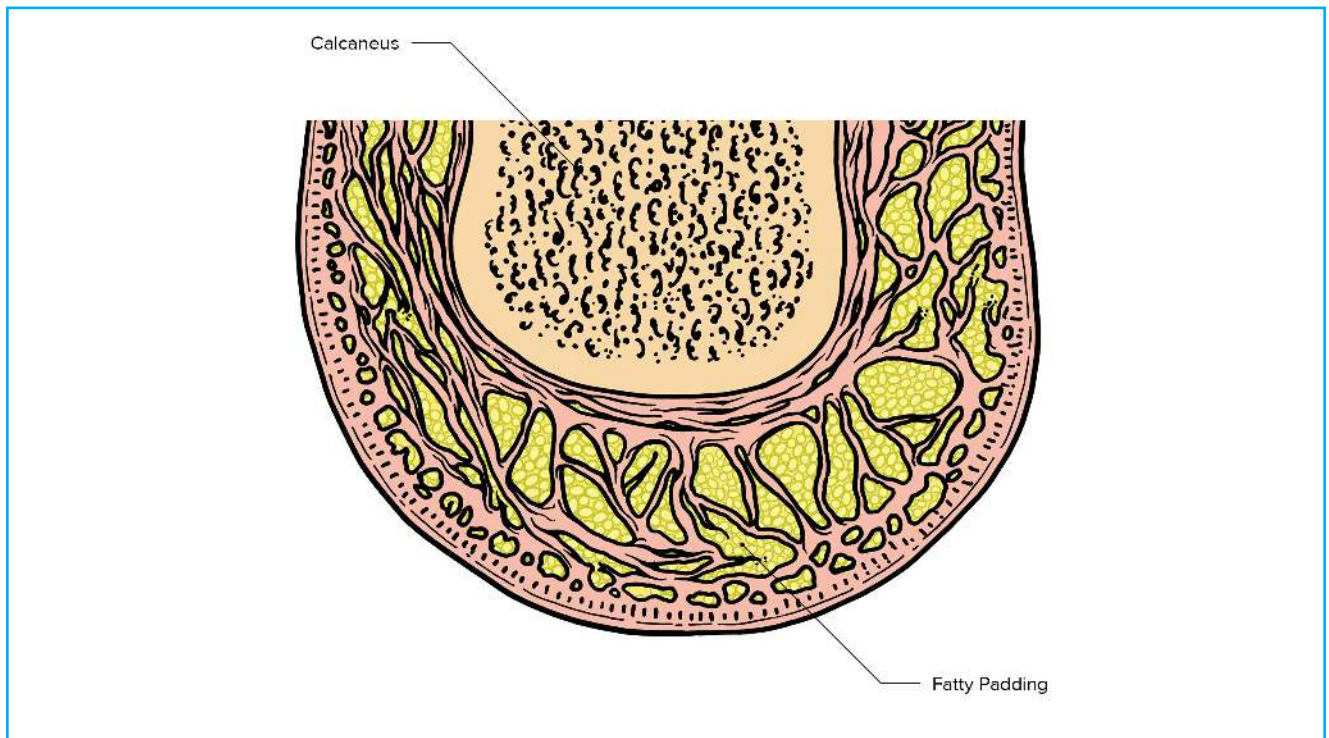


Figure 2. Heel cross section

HA to both feet in one treatment session. After 6 months, all subjects reported less pain, with over a third experiencing no pain at all. (Foumeteze et al, 2018). Unfortunately, the study did not continue past the 6-month assessment.

Others have theorised that a longer-lasting filler would provide longer-lasting results. Gusenoff et al (2016) reported that autologous fat transfer to the plantar fat pad provided improved foot pain compared to the controls, who were treated conservatively. Pain was even more improved at 12 months than it was at 6 months in the fat transfer group. The authors concluded that fat grafting for forefoot fat pad atrophy significantly improves pain and disability outcomes and that pedal fat grafting is a safe, minimally invasive approach to treat fat pad atrophy (Gusenoff et al, 2016). Unfortunately, this study did not continue past the 12-month assessment.

Gusenoff and colleagues then followed up with a 2-year study, demonstrating continued pain relief at 2 years with autologous fat grafting (Minteer et al, 2018). These researchers then sought to demonstrate why patients had continued relief. Using a mean of 5.8 ccs of fat per foot, they used magnetic resonance imaging (MRI) to measure the 3-dimensional volume of the fat pad before and 6 months after fat implantation (Ruane et al, 2019). They concluded that fat grafting significantly increased the metatarsal fat pad volume, and this could contribute to the lasting pain relief in these patients (Ruane et al, 2019). Hopefully, future papers will report whether these patients continue to have

pain relief, and how long this improvement lasts. Since fat grafting in other parts of the body is considered permanent, it is hopeful that fat grafting to the plantar fat pads will provide long-term relief for patients.

Long-lasting improvement has been demonstrated by Dr Balkin, circling back to his silicone studies, who treated 1585 patients over a 41-year time period. He noted that 60% to 80% of patients experienced moderate to complete pain relief, but approximately half of these patients required booster injections at year 1–20 (Balkin, 2005). It seems remarkable that a patient could go 20 years before requiring a ‘booster’ injection. To the author’s knowledge, there are no other reports documenting any injectable filler’s efficacy over this lengthy a time period.

Equally remarkable is the relative low incidence of complications when true medical grade silicone is used. Zappi et al (2007) looked at biopsies of facial skin for depressed scars where silicone had been injected 1–23 years earlier. The microscopic study revealed that, in all cases, there were significant amounts of injected silicone remaining in the targeted areas, which failed to illicit any significant adverse reaction (Zappi et al, 2007). However, what about the foot? Wallace et al (2004), in a 38-year study, concluded that injected silicone seemed to be stable, and the injected tissue showed consistent findings over varying durations. They reported that silicone injections in the fat pads for the treatment of atrophy and loss of viable tissue show a histologically stable and biologically tolerant host

response that is effective. The fibrosis and host response thicken the tissue underlying the bony prominences and enhance the viability of the fat pad (Wallace et al, 2004). Yet another study, from Manchester, UK, reported no significant side effects after their investigation into silicone in the plantar fat pads. The researchers, Carine et al (2000), reported no evidence of migration, infection, rejection, inflammation or allergic reactions in their subjects receiving silicone. After an exhaustive review of the literature in 2010, Bowling et al published their findings on use of the silicone in the feet. They reported that injectable silicone is just as safe and effective as facial dermal fillers and as a soft tissue substitute for treating pressure-induced foot disorders, based on several independent evaluations and studies (Bowling et al, 2010).

Diagnosis and treatment of metatarsalgia in an aesthetic clinic setting

Essentially, metatarsalgia is a symptom and not a diagnosis. It is true that plantar fat pad atrophy is a common cause of metatarsalgia, but there is a myriad of other causes that must be ruled out. In the author's opinion, it is best to leave the diagnosis to our 'feet' colleagues, such as podiatrists and orthopaedists. If a patient has been worked up and is being treated conservatively with external padding, custom orthotics and anti-inflammatories, they may be a candidate for filler injections. It is reasonable to start with a HA filler, as it is temporary and can be reversed with an injection of hyaluronidase. If the patient experiences relief and wants a more permanent solution, autologous fat grafting and medical grade silicone are both effective options to explore.

Plantar fat pad atrophy is usually a clinical diagnosis with thinning of the fat pad and resulting underlying prominences easily palpated (Vella, 2015). The plantar fat pads are specific tissues made up of adipose chambers enveloped by fibrous septa (Morse, 2018). The goal of injections is to get filler in these chambers, where these fibrous septa help to trap product and prevent migration (Figure 2). In cases of long-term filler, the production of new collagen assists with this trapping of the product. Bowling et al (2010) noted that, with silicone, 'the newly formed mesh of fibrous tissue acts like a web to further entrap and retain silicone fluid where deposited' (Bowling et al, 2010).

Posterior tibial nerve block

Injection of the chosen filler is usually a straightforward process, as long as the patient is adequately anaesthetised. The most effective way to numb to plantar surface of the foot is with a posterior tibial nerve block (Figure 3). The posterior tibial nerve conveniently makes itself accessible by injection, as it runs posterior to the medial malleolus. It runs in a neurovascular bundle with the posterior tibial artery and nerve within the tarsal tunnel, along with the

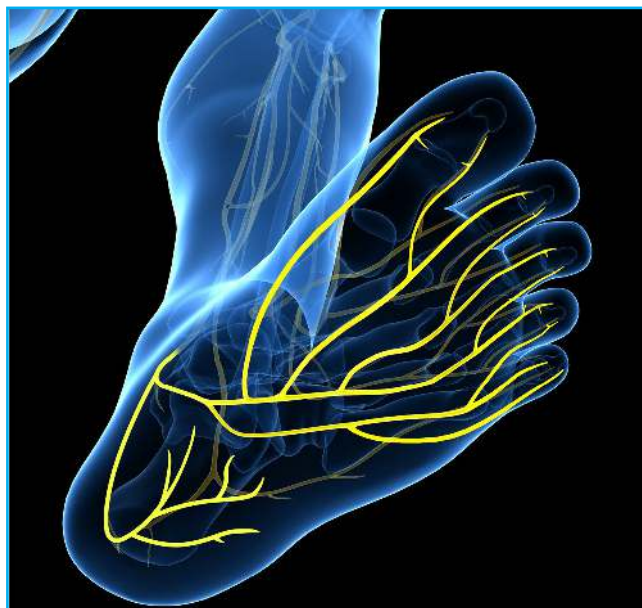


Figure 3. Bottom view of the foot

posterior tibialis tendon, the flexor digitorum longus tendon and the flexor hallucis longus tendon (Figure 4). To inject the local anaesthetic, locate the posterior tibial artery pulse and move posteriorly 0.5 to 1.0 cm towards the Achilles tendon (and away from the malleolus). Direct the needle at a 45-degree angle in the anterior medial plane and insert the needle, usually 27 G, towards the tibia. Avoid the artery and nerve itself, and infiltrate the area with 3–5 ml,



Figure 4. Tarsal tunnel anatomy

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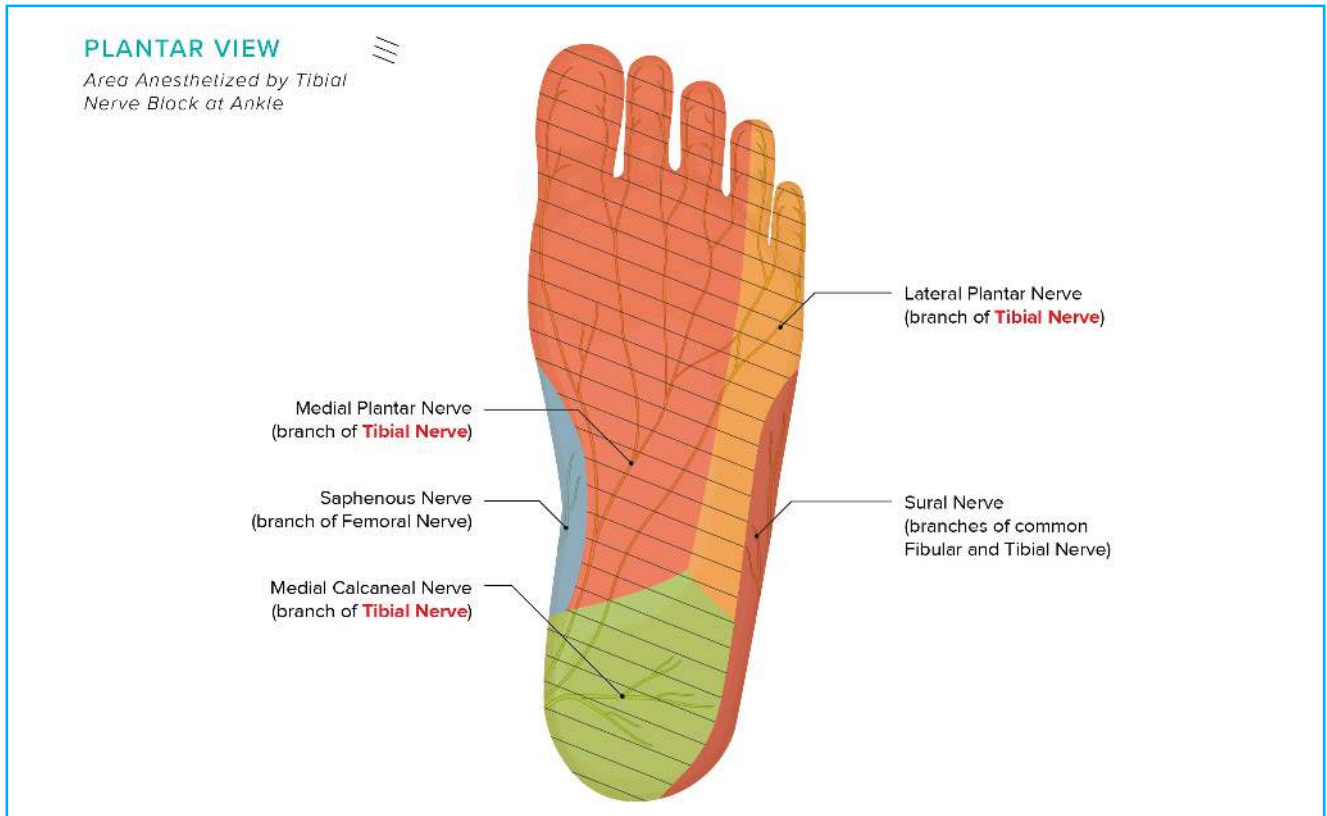


Figure 5. Plantar view of the foot

ideally not more than 10 ml, of anaesthetic. Sometimes, it is helpful to advance the needle to bone and then withdraw 3–5 mm before injecting. Blocking the tibial nerve here renders most of the sole of the foot numb (Figure 5).

If lidocaine without epinephrine is used, the block will last about 3 hours. The patient will be able to ambulate after treatment, but driving is not recommended. Patients will often say they feel like they are walking ‘with bricks’, ‘blocks of wood’ or ‘on thick padding’. Any patients with balance issues or lower extremity weakness should be carefully monitored after treatment to avoid falls.

Injection to plantar fat pads

When injecting the filler, the clinician should palpate where the metatarsal heads or calcaneus is most prominent, indicating the thinnest part of the fat pad. Then, insert the needle, tap the periosteum and withdraw a few millimetres, depending on the degree of fat pad atrophy. Keep in mind that a normal healthy foot pad measures anywhere from 1–2 cm in thickness (Boughton, 2017). The optimal thickness of the heel pad to eliminate pain is anything greater than 8.77mm (Lopez-Lopez, 2019). Furthermore, ambulation will help disperse the product throughout the fat pad, so the patient may ultimately need a booster injection. The recommended amount to inject varies from 0.2– 0.5 ml at any one site. Most authors recommend a total of 1–2

ml per foot for silicone (Bowling, 2004) or 4–6 ml for fat (Gusenoff, 2016), but this widely varies depending on the degree of atrophy. The greatest amount of silicone injected to a patient at a singular plantar site was 17.8 ml (Bowling et al, 2010), and it continued to be asymptomatic for 30 years according to the authors.

Contraindications and complications

Dermal filler injection to the plantar fat pads is contraindicated in any patient who has foot pathology causing metatarsalgia that is unrelated to fat pad atrophy. A podiatry or orthopaedic review to rule out other medical issues is a must before considering injections. The author recommends only treating patients who have been diagnosed with fat pad atrophy and have grown tired of their current conservative treatment options, such as padding or orthotics. The usual contraindications to various dermal fillers still apply, such as history of allergies to the particular product, regardless of the anatomic location of the injections.

Fortunately, complications of dermal fillers in the feet are less common and less potentially devastating than fillers in the face. There has never been a report of blindness or necrosis with plantar fat pads injections (to the author’s knowledge). Due to the constant pressures that human feet are subject to, it is logical that migration

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of the product would be a top concern. However, as discussed earlier, the structure of the fat pads is conducive to containment of the product and weight-bearing helps to distribute the product within the fat pad. Bowling et al (2004) investigated the possibility of silicone migration in their report. They noted that, of 885 patients injected to the foot, only 17 (1.9%) developed a soft mass of migrated fibrous tissue and only four patients (0.45%) required intervention to remove the mass because of discomfort while wearing shoes. Balkin (2005) noted, in his study of 1585 silicone-injected patients, that, 'there were some local and generally asymptomatic fluid migration that occurred in over-injected feet, but no other complications, such as tumours, infection, inflammation, rejection or allergic responses have been observed'.

Infection, as always, is a possibility with any injection, but can be mitigated with proper cleansing and sterile technique. Adverse events related to the nerve block can rarely occur, such as injection of anaesthetic to the tibial artery or injury to one of the tendons in the tarsal tunnel. Ultrasound-guided tibial nerve block can help delineate the anatomic structures in the area and decrease this risk. The risks associated with autologous fat harvesting and grafting are most often related to possible overdose of lidocaine in the tumescent fluid, technique of harvesting resulting in unevenness in the donor site and contamination of the fat while processing it for reinjection. Additionally, there is always the small possibility that the fat cells will not survive the transplant. If one considers the use of silicone, keep in mind its controversial past, fully disclose the risks to the patient and use only medical grade silicone.

Conclusions

Dermal filler injections to the plantar fat pads are a reasonable, quick, easy and efficacious option to treat fat pad atrophy. Aesthetic practitioners are already seeing these patients for facial injections and have the skills needed to perform this procedure. Many patients with metatarsalgia and/or heel pain secondary to atrophy could benefit from this treatment. It can be gratifying for the aesthetic provider to help patients experience less or no foot pain and increase their quality of life.

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