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Exploring Korean Hand Therapy in Treating Plantar Fasciitis: A Pilot Study

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ABSTRACT

Exploring Korean Hand Therapy in Treating Plantar Fasciitis Pain: A Pilot Study

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PF is one of the most common foot and ankle problems. People with PF experience mild to severe pain that interferes moderately with activities of daily living (ADL). Due to chronic pain that interferes with ADL, people with PF often use non-steroidal anti-inflammatory medications and/or acetaminophen. These medications alleviate pain but cannot eliminate it. Additionally, with chronic use, these medications can cause well-known adverse side effects. The purposes of this study were to investigate the effect of Korean Hand Therapy (KHT) in (1) treating the pain experienced in patients with plantar fasciitis (PF), (2) evaluating its impact on functionality, and (3) assessing participants' self-adherence to treatment. A pre-post mixed methods pilot study was conducted with 28 participants. Baseline measures included a demographic questionnaire, height and weight, a 10-point pain scale, the foot function index (FFI), and measurement of the plantar fascia via ultrasound. As a group, participants were taught about KHT and how to self-administer it. Participants then self-administered KHT for four weeks. Three weekly electronic surveys were sent asking participants about their pain and use of KHT. After four weeks, participants returned for final data collection, including a focus group. Baseline measures, except the demographic questionnaire and height and weight, were repeated. Thickness of PF was not correlated with pain at baseline (r = -0.14, p = 0.47). Compared to baseline, pain was significantly reduced after the initial KHT treatment on the first visit (4.875 vs 2.625, $p < 0.00$) and at the 4-week follow up (4.875 vs 2.528, $p < 0.05$). On average for all four weeks, participants reported 5.48 (SD 1.50) days of self-guided KHT per week. PF thickness was not significantly reduced at the follow up session at 4 weeks (t =1.16, p = 0.26). FFI scores were significantly improved between baseline and four weeks: Pain (t = 3.80, $p < 0.00$), Activity Limitation (t = 2.64, p = 0.02), and Disability (t = 4.74, $p < 0.00$) and overall FFI (t = 4.83, $p <$ 0.00). Findings suggest KHT may reduce pain and increase functionality for people who experience PF. While the sample was small, KHT is low-risk, low-cost, and easily self-administered. Further investigation is needed on the long-term effects of KHT and its ability to generally alleviate all types of pain.

Keywords: Korean Hand Therapy, hand therapy, plantar fasciitis, acupressure, pain relief, complementary alternative modality

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Plantar fasciitis (PF) is one of the most common foot and ankle complaints resulting in approximately one million doctor visits and $284 million dollars in healthcare costs annually (Riddle & Schappert, 2004; Rosen Baum et al., 2014). PF results in the degeneration or proliferation of the fibrous tissue that connects at the calcaneal tubercle to all five toes. This ailment can occur with or without inflammation and causes dysfunction and pain.

The prognosis of PF varies. For most, recovery takes up to 6 to18 months (Dyck & Boyaijian-O'Neill, 2004), but one cohort study (n = 174) found majority of its participants experienced prolonged symptoms lasting more than 6 to 18 months. This study found many people who suffer with severe PF experience prolonged symptoms, specifically "80.5% after 1 year, 50% after 5 years, 45.6% after 10 years, and 44.0% after 15 years" (Hansen, Krogh, Ellingsen, Bolvig, & Fredberg, 2018, p. 8).

However long it takes people to recover, pain that interferes with activities of daily living is an ongoing complaint. According to the 2013 National Health and Wellness (NHW) survey (n=75,000), 28% of patients with PF described their pain as mild, 45% as moderate, and 25% as severe. More than half reported daily pain that interfered moderately with activities, and about one third reported severe interference (Nahin, 2018).

Due to the ongoing foot and heel pain experienced by these patients, use of pharmaceuticals for pain control is common. In fact, according to the NHW survey more than two-thirds of participants with PF reported using over-the-counter products for pain management. The most common over-the-counter medications included non-steroidal anti-inflammatories (49.47%) and acetaminophen (26.93%) (Nahin, 2018). These pharmaceuticals help relieve pain but do not completely eliminate it for some patients. Additionally, when

chronically used, these medications put patients at higher risk of gastrointestinal ulcerations and bleeds, kidney and liver damage, stroke, myocardial infarction, and drug interactions.

To achieve better outcomes, alternative modalities may be helpful and should be investigated. One such modality is Korean Hand Therapy (KHT), a traditional oriental medicine developed in 1975 by Tae-Woo Yoo, OMD, Ph.D. KHT is a type of acupressure that includes a micro-meridian system that maps organs, muscle, and skeletal systems to corresponding points (CPs) on the hands. When non-invasive pressure is applied to areas of the hand that theoretically reflect where the pain is felt in the body, these CPs are tender. Gently rubbing these points alleviates pain in the associated regions (Lobash, 2015). Unlike other acupressure techniques, KHT can be easily applied and self-administered, which may improve adherence. Several studies have found that acupressure is effective in alleviating pain perceptions among a variety of patients (Chen & Wang, 2014; He, Tong, Li, Jing, &Yao, 2013; Yeh et al., 2015). Many of these studies focused on acupressure of the leg, foot, and auricle, but not the hand, and none focused on treating plantar fasciitis pain. Therefore, the purpose of this pilot study was to investigate the effectiveness of KHT in treating pain experienced in patients with plantar fasciitis, the impact on functionality, and participants' self-adherence to treatment.

Methods

A power analysis was done to determine an adequate sample size using GPower 3.1 (Universität Kiel, Germany). The function "ANOVA: repeated measures, within factor" was used, setting power to 0.80, alpha of 0.05, medium effect size of 0.25, with 5 repeated measurements. This resulted in a required sample size of at least 21 participants. Therefore, a four-week, pre-post design pilot study was conducted on the campus of a large private university

in the western United States. The study was approved by the university's Institutional Review Board, and data were collected from August to October 2019.

Recruitment was done via flyers posted at a health clinic, the athletic building on campus, and stores that sell athletic shoes. People who were interested in the study called the primary investigator (PI), who answered their questions about the study and screened them to determine if they met the inclusion criteria. Individuals were eligible to participate if they met the following criteria: (1) self-reported that they had been diagnosed with plantar fasciitis; (2) were ages 18 to 65 years; and (3) spoke English. People were excluded if they had injuries or wounds on their hands or comorbidities of other chronic pain syndromes. Interested individuals who met these criteria and expressed interest were invited to participate.

Procedures

Upon arrival on the first day of the study, informed consent was obtained from each participant. Then participants completed demographic and functionality questionnaires and rated their pain. The demographic questionnaire captured data needed to accurately describe the sample. Questions included participants' sex, year of birth, ethnicity, marital status, annual household income, highest level of education completed, whether they have health insurance and a regular source of healthcare, and if they had tried any other Asian complementary therapies to treat pain or illness and, if so, what they used it for. All participants were weighed and measured with a Seca 214 mobile stadiometer and Seca Robusta 813 scale in light clothing with shoes and accessories removed. Height was measured twice. If measurements were not within 0.1 cm, a third measurement was taken. Results were used to calculate body mass indexes (BMIs) using the Centers for Disease Control's (CDC; 2014a) on-line adult BMI calculator and categorized

per the CDC's BMI categories (CDC, 2014b). The final baseline measurement included ultrasounds of participants' feet to measure plantar fascia thickness.

Next, participants were taught about KHT and how to self-apply it for PF. We began teaching KHT with a brief history of KHT and the theory behind it. Then we assessed each participant using KHT assessment tools and found the CPs for therapy. For the plantar fascia, the CPs of therapy are located on the palmer tip of the 5th digit. The CPs on the hand correlate with the side of the body that is affected. For example, if the right plantar fascia is inflamed, the CPs will be on the right 5th digit. To begin, we cleaned the finger with alcohol and identified the CPs using a blunt-ended probe to find tender spots, which are areas that are more painful than the surrounding skin when prodded. According to KHT theory, these spots reflect the pain felt in the foot. The most tender point or points were marked with a surgical pen to identify the specific points for therapy. If the participant had PF in both feet, this procedure was done on both hands.

Once the CPs were identified, self-adhesive beads called pellets were applied to them. We taught participants to massage the area over the pellets to stimulate the CP. Participants were given a probe and extra pellets and were taught how to locate the CP themselves. We taught them that after they got accustomed to KHT, they would be able to find the CP with their thumbs and would likely not need the pellets for ongoing therapy. Participants were asked to do KHT three times a day for 5 to 10 minutes and whenever they had PF pain for the next four weeks. After the lesson and application of KHT, participants again rated their pain.

At the end of weeks 1, 2, and 3, participants received an email with a link to a Qualtrics survey asking them to rate their average pain from PF that week, the interference from PF in their ability to function that week, how many days per week they did KHT at least once, and what else, if anything, they did to treat their PF pain.

At the end of week four, participants returned to the study site and again had their plantar fascia measured via ultrasound, completed the foot functionality questionnaire, rated their pain, and completed a final questionnaire that asked for feedback on the study, whether they would continue to do KHT, and if they had followed their healthcare providers' recommendations to treat PF.

Finally, participants took part in one of four focus groups, which were each approximately one hour in duration. Focus groups were recorded and transcribed verbatim. At the beginning of each focus session, participants committed to keeping the focus group content confidential. During the focus groups, we asked participants about their experience with KHT and its impact on their PF-related pain and functionality.

To honor participants' confidentiality, code numbers were assigned, and any identifying information was removed from surveys and transcription. Surveys and transcripts were securely stored in a password protected online storage system. Each participant was compensated for the their time as follows: (1) participants who completed the baseline data collection and KHT instruction received $20, (2) those who completed the weekly Qualtrics surveys received a $5 gift card for each of the three surveys they completed (up to $15), and (3) those who completed the final assessment and focus group at week four received $20. The maximum compensation per participant was $55.

Instruments

Pain scale. A 0 to10 point pain scale was used for participants to rate their pain intensity. A pain score of 0 indicates no pain and 10 indicates experiencing the worst possible pain. Pain measurements were taken at baseline, after treatment, weekly for 3 weeks, and at the final assessment. This pain scale is widely used in clinical and research settings.

The Foot Function Index. We chose the Foot Function Index (FFI), for its reliability, internal consistency, and specificity to foot function, which directly relates to PF. Reported test-retest reliability of this tool ranges from 0.97-0.69 with an internal consistency range of 0.96-0.73. This FFI consists of 23 self-administered questions divided into 3 subscales that include Pain, Debility, and Activity Limitation (Budiman-Mak, Conrad, & Roach, 1991).

Ultrasound. Ultrasound is a reliable tool for the diagnosis and prognosis of PF (Draghi et al., 2017; Mohseni-Bandpei et al., 2014; Wu, Zhang, Gao, & Luo, 2019). Each participants' feet were examined with ultrasound using a Butterfly iQ handheld device and an iPhone 10 as the screen. Two researchers, who are Point of Care ultrasound trained, completed the ultrasounds. The plantar fascia was measured in the longitudinal view at the junction of the plantar fascia and calcaneus. A plantar fascia thickness of >4 mm was considered abnormal. The positive predictive value for PF is 84% (Abdel-Wahab et.al. 2008); Abul, Ozer, Sakizlioglu, Buyuk, & Kaygusuv, 2015; Draghi et al., 2017; Fabrikant & Park, 2011). Ultrasound results at the fourth week indicating plantar fascia thinning would suggest resolution of inflammation was beginning (Kane et al., 2001).

Data Analysis

Demographic data were analyzed using simple descriptive statistics with univariate analysis. We ran a repeated measures ANOVAs to determine if KHT significantly impacted plantar fasciitis severity as measured by the FFI. Age, sex, and ethnicity were included as covariates. Because pain scores on the 10-point pain scale were recorded at six different time points, with various lengths between measurements, linear mixed modeling was used to determine if pain scores significantly changed between time points. An "unstructured" covariance structure approach was used, again controlling for age, sex, and ethnicity. In simple

terms, linear mixed modeling was used to account for multiple responses at varying time points, and it also accounts for responses from the same participant being more similar than responses from other participants.

Qualitative data analysis involved: (1) repeated listening to recordings and reading of the focus group transcripts, (2) organizing by dividing data into categories, (3) coding according to topics, (4) analytical coding to understand meaning, (5) and coding for themes that identified meanings that ran throughout the data and between topics. Patterns were identified and findings synthesized that yielded rich insights (Sandelowski, 2000) into participants' experiences with KHT and PF.

Results

Participant Characteristics

A convenience sample of 28 participants was acquired. One person, who would have been the 29th participant, decided not to participate in the study shortly after completing informed consent. Only six participants had any missing data, two of whom did not complete any data collection after day one. Two others did not attend the last data collection period, and the other 2 did not participate in one or more weekly questionnaires. Not including demographics, our 28 participants could have responded to 2352 questions, and they completed 2100 questions for 10.7% missing data.

Demographic information appears in Table 1. The sample was nearly 2/3 female with the majority of the participants being insured and Caucasian. Ages ranged from 19 to 76 years old with a mean age of 41.95 years (SD = 19.85). 15 participants had normal BMIs, 7 had overweight BMIs, and 6 had obese BMIs. The majority of the sample responded that they had never done complementary alternative Asian modalities before. 25 out of the 28 participants,

who were measured via ultrasound, had plantar fascia sizes that met the diagnostic criteria of ≥ 4 mm. Those who did not met criteria had plantar fascia sizes ranging from 3.3-3.7 mm.

Pain

Change in pain, as assessed on the 10-point pain scale, between time points was evaluated using a linear mixed modeling approach, controlling for age, sex, and ethnicity. With six time points, there are 15 pain comparisons that could be made. Two of the 15 comparisons were significant (n = 16, AIC 339.50, levels = 13, parameters = 27). Compared to the baseline assessment (time 1), pain was significantly lower post-treatment on day 1 (time 2) (4.875 vs 2.625, $p < 0.00$). Compared to the baseline assessment (time 1), pain was also significantly lower on the final visit (time 6) four weeks later (4.875 vs 2.528, $p < 0.05$). All other comparisons of pain scores were not statistically significant (see Figure 1 & Tables 2 & 3).

Plantar Fascia Thickness

Thickness of the plantar fascia was not correlated with pain at baseline (r = -0.14, p = 0.47). Additionally, plantar fascia thickness was not significantly reduced at the final data collection session. Initial mean plantar fascia size in the affected foot (largest if both feet affected) was 4.7mm (SD = 0.10) and at follow up was 4.4mm (SD = 0.12), the difference was not statistically significant (t =1.16, p = 0.26). Furthermore, the plantar fascia size at follow up was not reduced below the diagnostic threshold for PF.

Foot Functionality Test

Foot function, as measured by the FFI, changed in a positive way over the course of the study. From initial assessment to the assessment four weeks later, the overall FFI score (t = 4.83, $p < 0.00$) and all three sub-scale scores (Pain t = 3.80, p < 0.00, Disability t = 4.74, $p < 0.00$,

Activity Limitation $t = 2.64$, $p = 0.02$) significantly improved. A decrease in a score indicated improvement. See Table 4 for more details.

Self-Adherence

On average, participants performed KHT on week one 6.04 (SD = 1.71) days, week two 5.12 (SD = 2.01) days, and week three 5.39 (SD = 1.41) days. For all weeks, participants averaged 5.39 (SD = 1.50) days. See Table 5 for full details.

Focus Groups

Twenty-three participants actively engaged in one of four focus groups. They shared their experiences about PF and KHT. Three themes evolved from data analysis: (a) what worked well, (b) hassles, and (c) efficacy of therapy.

Theme 1: What Worked Well

Many (n=14) participants identified aspects of KHT that worked well for them. They discussed KHT being convenient, simple and non-invasive, and inconspicuous.

Convenient. Some participants (n = 9) commented that KHT was convenient. The convenience stemmed from the ability to do the therapy throughout the day and sometimes simultaneously with other activities. One participant conveyed that KHT could be done at any time or location by saying, *"I mean I* [would] *do* [KHT] *in bed before I get up,* [I'd] *do it in bed after I* [laid] *down,* [I'd] *just do it while I'm sitting at my desk or driving"* (Participant 720).

Participants also commented that the therapy required little time, which added to the convenience of the therapy. One participant stated:

> *A lot of times during the day, you don't have very much time to do extra stuff on top of what we are already doing, so it's nice. I would just do* [KHT] *a little bit before bed and then sleep with the patch on my finger so that way I didn't have to take a whole bunch of*

> *time out of my day . . . . So, it's super convenient, because I could do it literally every day without a problem with it interfering with my day.* (Participant 346)

In addition, other treatments for PF require equipment, such as rolling one's foot on a frozen tennis ball or water bottle, but KHT does not require equipment. One participant explained this by saying:

> *I could remember it in the middle of my day, "oh I forgot to do my hand therapy today" and like, the exercises that my doctor and physical therapist have given me, where I have to remember in the morning because there's equipment at home that I have to use and if I forget, I have to try and remember when I get home at night. This I can just do whenever.* (Participant 633)

Initially, a probe was used to find the CPs on the finger and a small pellet was applied to the CP. Thus, the probe and pellet helped participants initiate the therapy. While a few participants (n = 4) expressed that the pellet was helpful throughout the four-week study, others commented that after a few KHT sessions on their own, they could do it without the probe and/or pellet (n = 12). One participant explained:

> *I could just do it with my thumb nail and find the spot. I thought it worked even better than the . . . little* [pellets] *did. . . . I used the probe first for just a few days. Then you didn't need it anymore. You knew where you were going, knew what you were feeling for, and how it was supposed to feel. So, I could even just do it with the thumb nail of from the same hand . . . . It's easy once you know what you are feeling for.* (Participant 720)

Simple and non-invasive. A reoccurring comment about KHT from multiple participants (n =11) was that *"It was simple and easy to do."* One aspect that made KHT simple was the non-invasive nature of the treatment. KHT applies acupressure to the hand, which unlike acupuncture

keeps the skin intact, reducing the risk of infections, bleeding, or accidental punctures that can occur with acupuncture. One participant commented on the non-invasive nature, *"I liked that* [KHT] *was non-invasive. Like, I didn't have to get a needle"* (Participant 352). Similarly, another participant commented, *"I would not hesitate to suggest* [KHT] *as an option because it's so non-invasive and so easy"* (Participant 373).

Additionally, a few participants commented on the ability to easily self-apply KHT because the therapy involves a readily accessible body part. Unlike acupuncture or acupressure on the body, foot, or auricle, KHT is easily applied to the hand. One participant explained the accessibility of the therapy by saying, *"I loved how easy it is to manipulate my pinkie. . . . I love the accessibility of it"* (Participant 495).

Another participant further supports the ease of the therapy due to the ability to self-apply the therapy by saying:

> *And so, I think, some of the nice things about it were the ease of doing it and self-induced so that was useful. . . . It's easy just to stick my thumb* [on my little finger] *and start massaging. And so, I think it's simple, it's something that can be done, and it's almost become a little bit of a habit when I start to feel my foot* [hurting], *I just do it.* (Participant 838)

Inconspicuous. A couple participants commented that KHT was inconspicuous, which is a benefit. One participant commented on the privacy of doing the therapy by saying:

> *I felt it to be very functional for whenever I kind of notice or feel* [the PF pain]. . . . *It's super easy and discrete. It's not like people are going to stop you and say, "what are you doing?* (Participant 373)

Similarly, another participant said, *"yeah, like no one will know* [when you are doing KHT]*"* (Participant 906).

Overall, many participants made positive comments on what went well with KHT. Convenience, simplicity, and the non-invasive, inconspicuous aspects were found to be the themes.

Theme 2: Hassles and Complaints

Though many participants commented on what went well with KHT, participants also commented on what they felt was troublesome with the therapy. Their complaints included pellets falling off, soreness of the little finger, and difficulty locating CPs.

Pellets not staying on. Several participants (n = 6) complained about the pellets. Many felt that the pellets fell off too easily. One participant conveyed this frustration by saying, *"That band aid thing* [pellet] *that you put on -- it was kind of a hassle. It kept falling off"* (Participant 007).

Another participant commented that because the pellets were a hassle, he quit using them. He said, *"I just could not keep those* [pellets] *on for anything, so I quit using them pretty fast"* (Participant 720).

Additionally, participants commented that working with or washing one's hands caused the pellets to fall off quickly, as this participant explained, *"I felt the pellets fall off pretty quickly, especially from washing your hands a lot or doing anything really with your hands and then the tape would slide off too. So, that became a little bit difficult"* (Participant 043).

To help remedy the situation, a few participants put their own bandages or tape around the pellet to help the pellet stay in place. One participant explained how this helped by saying, *"I taped it* [the pellet] *on and that would last maybe a couple of days"* (Participant 007).

Soreness of the finger. Although KHT is non-invasive, eight participants complained of discomfort in the little finger where the therapy was applied. One participant provided an explanation as to why this may have occurred by saying, *"With the Korean Hand Therapy, I do think that it makes your finger sore. You're rubbing around against that bone. . . . It just feels funny"* (Participant 300).

KHT was applied several times a day for four weeks to the little finger on the same side of the body as the foot with PF. Due to the repeated rubbing of the little finger, soreness was a prevalent complaint. Some participants described this pain by saying, *"my pinkie felt bruised"* (Participant 369).

Difficulty independently locating the CP. A few participants reported that they had trouble finding the CPs. One participant emphasized this by stating:

> *I had a hard time locating* [the CP]. *When,* [the instructor] *did it, . . he got right on it.* [I felt a] *little zing, and I could feel exactly where it was. I just couldn't get that same* [feeling]*, couldn't find that same point. So I ended up just sticking the* [pellet there] *and just massaging and rubbing and hoping that* [it] *. . . would heal.* (Participant 300)

Similarly, a few participants explained their challenge of finding the CPs. To remedy this, one participant suggested marking the point with something more permanent. To provide a more permanent marking, one participant recommended,

> *Right at the beginning. . .* [the researcher] *identified the spots. Then it was kind of left up to us to. . . get the placement right. . . or. . . find that spot again. . . . I'd think I was on the same spot. . . . I don't know if there's any kind of follow up or . . . short of tattooing. . . a little henna or something right there* [referring to the participant's little finger]." (Participant 838)

Although participants had positive comments about KHT, they also discussed complaints and hassles associated with KHT.

Theme 3: Efficacy of Therapy

Participants had varying opinions about whether KHT was effective. During the focus group discussions, seven participants expressed that the therapy was effective; seven participants expressed that it was somewhat effective; three participants were unable to determine effectiveness; and four participants expressed that it was ineffective. Two focus group participants did not comment on effectiveness of KHT.

KHT was effective. Among the seven participants who felt the therapy was effective, one participant explained:

> *I was amazed that* [KHT] *actually worked. I came in a little sceptical, and the people that I would try to explain it to, relatives and family members, of course, they were sceptical too until I . . . demonstrated. I have a sister-in-law with really a lot of foot pain,* [and it] *actually helped her a little bit. . . . I was pleased with results.* (Participant 544)

Another participant agreed that KHT was effective and commented, "*I am very much of a sceptic, so the fact that it did work for me, to alleviate a little, some mild pain, that was very surprising for me, but it was a good surprise obviously" (Participant 043).*

Another participant said that they quickly noticed results by stating:

> *I immediately saw really great results. . . . for two years I've had pretty intense pain in my right foot, and I've literally been pain free almost the whole time I've been doing [KHT]. So, I was really surprised, and I don't know how it works, but all I know is that I'm pain free.* (Participant 817)

Additionally, another participant explained how their PF pain was relieved by KHT, by explaining that the PF pain correlated with how sore their little finger was, and with stimulation of the CPs, both the pain in the little finger and plantar fascia were alleviated as stated by this comment:

> *I noticed . . . a little spot on my finger* [was] *sensitive and . . .* [as I would] *massage it . . . my foot pain* [would go away]*. . . . The pain in my finger went away as my foot pain went away. . . I didn't have any problem finding that spot because it was always tender, and as I massaged it, it would lose tenderness and go back to normal."* (Participant 544)

This participant's explanation is consistent with the theory behind KHT and how the CPs reflect the pain in their corresponding body part.

KHT was somewhat effective. Seven participants found that KHT was somewhat helpful. An example of a participant who felt that the therapy was moderately effective commented, "*So I would do it . . . as needed . . . but, who knows. . . I do feel better. . . I felt like it helped some*" (Participant 495).

Another participant with PF in both feet felt that one foot improved and the other did not. This participant commented: *"I had* [plantar fasciitis] *in both feet. One foot is a little better, and one actually feels worse. One hurts more than it did before"* (Participant 352).

Additionally, another participant noticed that the therapy was more effective for mild pain versus more severe. This participant also commented the pain severity was dependent on the activities of the day. When PF was more severe, KHT was less effective, and the participant had to augment the therapy with pain medication. This participant said:

> *I found that if it was like a mild pain or if it was just starting to bug me a little bit, it would be relieved, but if it was like after a long dance session or a long workout session,*

my feet were really, really hurting, then it wouldn't really do much, and I would have to take like ibuprofen or something. (Participant 043)

Similarly, participants also discussed whether they thought the therapy would be effective long-term. Some felt they had short-term relief but questioned if the therapy was effective long-term. Due to the questionable long-term effectiveness, some of these participants felt that KHT may be only moderately effective in treating PF. One participant stated:

Well maybe not in the long run. . . in the short run I could feel the difference. . . . It felt like the pain would go away. . . . My heel bruises or is bruised, but that would even go away for a short period of time. (Participant 007)

Unable to determine effectiveness. Three participants were not really sure whether KHT or something else had alleviated their PF pain. One participant reflected that the amount of pain was connected to the type of activity that day rather than the KHT. This participant commented:

Today I'm feeling. . . better, and it's kind of up and down, and a lot of it depends on, you know, was I out working in the yard? What had I been doing throughout the day? So, I would say [my pain is] *a, maybe a point or two better overall, but, it has kind of oscillated throughout the three, four weeks.* (Participant 838)

Another participant was also unsure, felt there were confounding factors, and stated:

I just question how much [KHT] does work and really, I mean, it seemed like mine got better, but I also was walking and running a lot less than when [my foot] was really hurting bad. So, I'm an engineer, so I like to see the numbers. It just seems a little weird that it helped, it works, but it did feel better sometimes when I did it. (Participant 281)

A few participants (n = 4) openly wondered if their pain relief was due to a placebo effect. For instance, one participant reflected, "*I thought often immediately after, I would* feel [some] *results, but. . . I am not sure if it was a placebo effect or what"* (Participant 720).

KHT was ineffective. Four participants felt that KHT was not helpful in alleviating their PF pain. For example, one participant, who found that KHT was ineffective but still tried to be consistent in doing it, said,

> *I didn't feel an immediate pain relief or anything like that. . . . And, I still did it. I, I tried to be consistent for the study's sake, but I was doing it four to five times* [a day] *those last two weeks. And again, didn't see* [or] *feel immediate results from that.* (Participant 838)

Likewise, another participant stated, "*Not anything really noticeable. . . . So, I mean, it may have helped, but I don't think so"* (Participant 906).

Thus, participants' perceptions varied about the effectiveness of KHT. The majority (*n* =14) expressed that the therapy was effective or somewhat effective, but others (*n* = 7) questioned its effectiveness or thought it was ineffective.

Discussion

PF is a condition that often causes prolonged pain. Because of the chronicity of PF, alternative pain modalities can be of value, especially if they help minimize reliance on pharmaceutical measures. KHT is a possible alternative modality that can provide some pain alleviation. In this pilot study, researchers found KHT significantly reduced participants' pain at time periods 1 and 6. FFI and all subscales were significantly improved, and participants overall averaged self-adherence for all weeks was 5.5 days per week. Ultrasounds of affected foot did not change significantly with the size of the plantar fascia not decreasing below the diagnostic

measurement for PF over the course of the study. Some participants expressed that KHT was helpful, and others questioned whether it was effective.

Limitations and Recommendations for Future Study

Though KHT is a possible alternative modality in the treatment of PF, there are limitations to this study that should be considered. Our pilot study had a small sample size. Future studies should include a larger samples size with the possibility of separating participants into two or even three groups including an intervention, control, and/or sham group. With sham and intervention groups, blinding of participants could be done. Additionally, having two separate groups, such as a sham and an intervention group, would help determine whether attention from researchers or the KHT made a difference in pain reduction. Also, a control group would help determine if it was the passage of time or the intervention that benefited participants.

Potential biases within the study need to be acknowledged. For instance, statistically significant differences in pain scores occurred between baseline and immediately after the initial in-person training and between baseline and the final in-person data collection. No other statistically significant differences in pain scores were found, including the differences between baseline and the pain scores obtained from the three-weekly online surveys. This pattern suggests that the presence of the researchers may have influenced participants' responses. Future studies could incorporate different methods of data collection. A possible suggestion would be designing a study with all in-person data collection in one group and only online data collection in a second group to determine if the presence of researchers during data collection influences participants' pain scores.

The discussion group transcripts provided greater understanding of participants' experiences than what the quantitative data alone could have provided. One limitation mentioned

by participants was the pellets falling off or the marking of the CP washing off. Because of these issues, many participants quit using the pellets and used their fingers or thumb to stimulate the CP. To address this issue, future studies could include a more permanent spot with long-term ink; one participant suggested henna as a somewhat more permanent marking option. Alternatively, researchers could reinforce that the pellets are to help them learn the location of the CP and are unnecessary for ongoing therapy, and that pellets falling off should be anticipated. Another suggestion would be to supply participants with superior adhesive tape to help pellets stay on longer.

In future studies, implementing a better assessment of how participants applied the therapy would be helpful. Although KHT was taught to participants, researchers did not have participants "teach back" or demonstrate KHT to assess their understanding. To benefit future studies, researchers could have participants "teach back"/demonstrate therapy at the initial session, make home visits to assess proper application, and/or do weekly checkups in which participants demonstrate therapy back to researchers, which would ensure proper self-application.

An additional recommendation for researchers would be to collect more information on participants, such as how long a participant has had PF. Duration of participants' PF could influence how effective KHT would be for them. It would be helpful to know if participants who have had PF for a short time experience better relief with KHT compared to participants who have had KHT for a year or more.

Lastly, though researchers asked participants to disclose other treatment modalities that they used throughout the study, regulating what types of alternative modalities could be done and or introduced during the study could help control for confounding factors. Regulations could

include not receiving steroid injections and/or not allowing new usage of orthotic, night splints, and taping. Though controlling some modalities may be realistic, excluding such things as NSAIDs may be impractical. An example of a possible confounding variable in this study occurred when one of our participants received a glucocorticoid injection just after the study began. Though this participant found improvement of their pain, this improvement could not be isolated to either the effects of KHT or the steroid injection.

Clinical Implications

Clinicians need to carefully consider implications when advising patients to use KHT. For instance, one plausible explanation of why some pain measurements were not significantly reduced compared to baseline is that participants may have experienced some pain reduction and then overexerted and re-injured their plantar fascia, causing their pain to increase again. This fluctuation could happen in PF because tendons go through phases of healing. During the inflammatory and proliferative phases of healing, the tendon is not as strong as it is in the last phase called remodeling (Reiman, 2016). Additionally, during the proliferative phase, pain is often decreased due to a reduction in inflammation (Chen, Donnelly, & Ji, 2020). Because pain is reduced during the proliferative phase, participants may perceive that the plantar fascia is healed and, therefore, overuse it by participating in rigorous activities while the tendon is still weak and healing. Clinicians should remember to briefly review the healing process with patients and advise them against overexerting too soon.

Another clinical implication to consider is that though pain reduction was not significantly reduced between baseline and data collection points 3, 4, and 5, pain scores were reduced. To a participant, a reduction in their own pain, however slight, may be clinically significant even if it is not statistically significant. For instance, consistent with our findings, if a

participant's pain score was 4.9 out of 10 at baseline, and 3.9 a week later, and 3.3 two weeks later, and increased slightly to 3.4 three weeks later, the 1.5 point reduction in their pain score over three weeks may be clinically meaningful, especially if the modality poses little risk and is cost effective.

Additionally, the most objective data collected were the ultrasounds of participants' plantar fascia. The ultrasound results indicated no statistically significant difference in the mean size of participants' affected plantar fascia between baseline and the end of the study, four weeks later. Although there was a small reduction in mean plantar fascia size, the mean was not reduced below the diagnostic criteria of PF. A reduction of plantar fascia size on ultrasound can signify the resolution of condition (Fabrikant & Park, 2011; Mahowald, Legge, & Grady, 2011; Mohseni-Bandpei et al., 2014). However, some studies indicate that recovery can take 6 to 18 months or even as much as 15 years, which indicates that PF is a condition that slowly resolves (Dyck & Boyaijian-O'Neill, 2004; Hansen, Krogh, Ellingsen, Bolvig, & Fredberg, 2018). Though KHT theorizes that it increases blood flow to an injured area and, thereby, reduces inflammation, long-term usage of KHT may be needed in order to determine whether it helps remodel the plantar fascia and results in reducing the plantar thickness (Park & Yoo, 2000). The time required for remodeling is important for healthcare providers to keep in mind and realize that KHT may not heal the PF immediately but may help address pain for some patients.

Lastly, with regard to foot function, we used the FFI, which is a valid and reliable tool, to assess functionality. Differences between baseline and the final data collection were significant in participants' overall foot function and the three subscales of the FFI. This assessment provides another way to determine the effectiveness of KHT in treating PF. The FFI provides functional measurements, such as difficulty walking, standing tip toe, limits to activity, and climbing up and

down stairs. It also provides details about pain experiences in different situations. The improvements found in foot function with use of KHT suggest that it may be helpful to patients with PF.

Comparison of KHT to Other Modalities to Treat PF

In contrast to Hansen et al.'s findings of PF symptoms lasting more than 15 years for some people despite using an array of treatments, Salvioli, Guidi, and Marcotulli (2017) found 80% of people with PF recover from heal pain within a year without intervention, and 90% recover with conservative treatment. Similarly, Thompson, Saini, Reb, and Daniel (2014) found that surgery is unnecessary for 85-90% of people with PF, and when treated conservatively, 80% recover without pain reoccurring long-term. Additional research also supports specific types of conservative measures to improve function and pain associated with PF, including manual manipulation, stretching, taping, night splints, and orthotics (Martin et al., 2014).

However, some treatment modalities for managing PF pain are controversial. For example, treatment with glucocorticoid injections may reduce pain for about one month, but risks include chance of atrophy, infection, and rupture (Guijosa, Muñoz, La Fuente, & Cura-Ituarte, 2007; Thompson, Saini, Reb, & Daniel, 2014). Other modalities, such as shock-wave therapy, laser therapy, dry needling, and pulse radio frequency, had low to moderate evidence in reducing pain compared to placebo; thus, researchers did not recommend these therapies or suggest further research to study their efficacy (Martin et al., 2014; Salvioli, Guidi, & Marcotulli, 2017).

Conclusion

PF is a chronic and painful condition for many people and is associated with millions of dollars of healthcare costs annually. Although PF often resolves over time, it can be very painful

and debilitating while the plantar fascia heals. It is important to find safe and effective ways to address PF pain. KHT is a minimally invasive, low risk, and low-cost therapy that can be easily and discreetly applied, making it appealing to healthcare providers and patients. This study indicates that KHT may be helpful for some patients with PF.

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Table 1. Demographics and Survey Responses

Characteristics	n	%	M (SD)	Min/Max
Sex				
Female	18	64.3		
Male	10	35.7		
Age (years)			41.9 (19.9)	18/75
BMI (kg/m2)			26.1 (5.3)	19.2/42.1
Ethnicity				
Non-Hispanic White	21	75.0		
African America	1	3.6		
Hispanic	3	10.7		
Other	3	10.7		
Plantar Fasciitis				
Right Foot	12	50.0		
Left Foot	7	25.0		
Both	6	21.5		
Used Asian CAM Before				
Yes	6	21.4		
No	22	78.6		
Health Insurance				
Yes	26	92.9		
No	2	7.1		
Regular Healthcare Source				
Yes	27	96.4		
No	1	3.6		
Education				
Graduated from high school	2	7.1		
Some college or technical	9	32.1		
Graduated from college or technical school	10	35.7		
Attended some graduate school	2	7.1		
Have a graduate degree	5	17.9		
Household income				
≤ $22,000	7	25.0		
$22,001-$49,999	4	14.3		
≥ $50,000	17	60.7		
Marital Status				
Never married	7	25.0		
Married	20	71.4		
Widowed	1	3.6		

Note: BMI = Body mass index, CAM = Complementary Alternative Medicine

Figure 1: Mean Pain Score Over Time

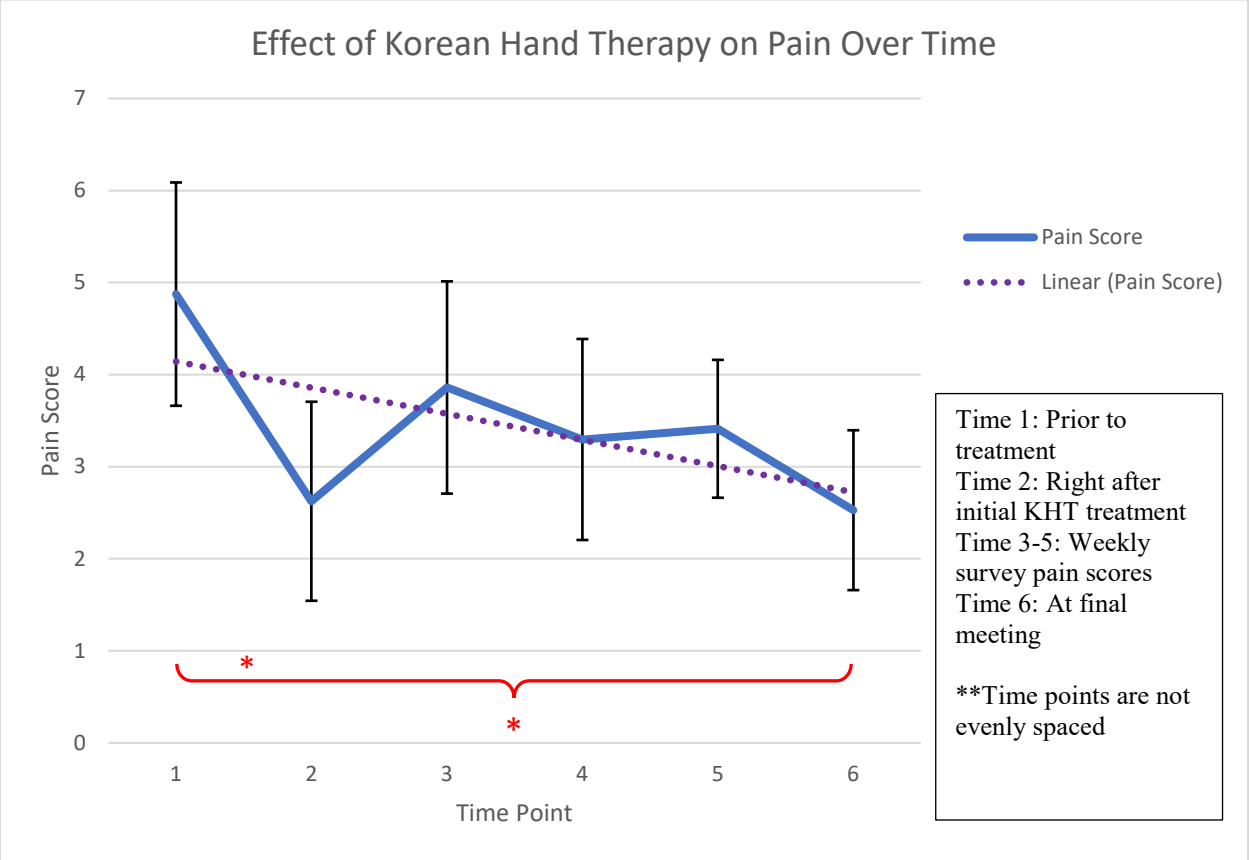

Table 2. Mean Pain Scores

Time	Pain Score	SD
1	4.875	0.569
2	2.625	0.507
3	3.861	0.530
4	3.296	0.557
5	3.412	0.382
6	2.528	0.443

Table 3. Pain Comparison

Time Comparison	1 Change in Pain (p value)	2 Change in Pain (p value)	3 Change in Pain (p value)	4 Change in Pain (p value)	5 Change in Pain (p value)	6 Change in Pain (p value)
1	-	2.25 (0.00) **	1.014 (0.96)	1.579 (0.06)	1.463 (0.18)	2.35 (0.048) *
2		-	-1.236 (0.334)	-0.671 (1.00)	-0.787 (0.946)	0.097 (1.00)
3			-	0.565 (0.874)	0.449 (1.00)	1.333 (0.514)
4				-	-0.116 (1.00)	0.768 (1.00)
5					-	0.884 (0.22)
6						-

*p <0.5. **p<0.01

Table 4. Mean FFI scores

	Pre-Score	SD	Post-Score	SD
Overall FFI	3.55	1.43	2.40	1.29
Pain Subscale	4.69	1.62	3.47	1.79
Disability Subscale	3.11	1.83	1.85	1.43
Activity Limitation Subscale	2.32	1.45	1.56	0.96

Table 5. Average Number of Days Performing KHT

Week	Mean	SD	Min	Max	n
1	6.04	1.71	1	7	24
2	5.12	2.01	0	7	25
3	5.39	1.41	3	7	23
Total	5.48	1.50			