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Treatment of lesser metatarsophalangeal joint plantar plate tear via Extracorporeal Pulse Activation Technology (EPAT) with MRI Follow-up: A case report

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Predislocation syndrome has recently gained attention as a common cause of lesser metatarsophalangeal joint (MTPJ) instability, contributing to tenderness, edema, and forefoot pain. The efficacy and utilization of non-operative treatments of plantar plate tears remains controversial; no current studies have conclusively indicated a successful restoration of a plantar plate tear by conservative treatment modalities. Within seven weeks, five total EPAT treatments were administered. Each weekly treatment consisted of 3000 pulses at 2.8 bars, performed directly at MTPJ 2-4 of the affected left forefoot. The patient was monitored on a weekly basis and progress measured utilizing the pain analog scale (0-10), subsequent MRI scans, and a complete return to normal, pre-injury activity. In the final follow-up examination, two months after the first EPAT treatment, the patient reported pain-free ambulation and a complete return to full normal activity. Subsequent MRI scans revealed no evidence of defects with notable improvements in structural integrity to the previously torn plantar plate. The results of this case report demonstrate the potential viability of shockwave therapy for the treatment of plantar plate tears. Further investigation may help to challenge the current standard of care and to provide a better, modern solution to an age-old debate between operative and nonoperative treatments of plantar plate tears

Keywords: plantar plate, metatarsophalangeal stability, lesser metatarsophalangeal joints, Extracorporeal Pulse Activation Treatment.

Pain and agony at the lesser metatarsophalangeal joint (MTPJ) are a typical objection, and a few causes have been depicted including injury, instability, synovitis, and other incendiary conditions [1,2]. Chronic inflammation of the fibrocartilaginous anatomy can lead to a tear and eventual luxation of the lesser metatarsophalangeal joints. If not treated appropriately, the plantar plate injury could further predispose the patient to a multitude of forefoot pathologies. The significance of the plantar plate as a static limitation to lesser MTP joint stabilization and separation has been very much recorded, and injury of the plantar plate assume a critical job in the advancement of sagittal plane MTPJ instability [3]. In this way, predislocation disorder has as of late picked up consideration as a common cause for lesser MTPJ

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instability, adding to tenderness, edema, and forefoot torment.

Historically, surgical repairs of plantar plate tears have resulted in poor outcomes [4]. Generally, the operative treatment of lesser MTPJ instability incorporated an assortment of methods including synovectomy, capsular delicate tissue releases with reefing, flexor to extensor ligament exchange, phalangeal and metatarsal osteotomies, and even digital amputation. Distal metatarsal osteotomies yielded great outcome for decompression and realignment of the included joint, at the same time, none of these surgical techniques tended addressed the main cause of MTPJ instability which is plantar plate rupture [5,6,7]. As a result, the efficacy and utilization of non-operative treatments of plantar plate tears remains controversial; no current studies have conclusively indicated a successful restoration of a plantar plate tear from conservative treatment modalities.

In addition, despite numerous indications, benefits, and its well documented efficacy, previous research regarding the use of EPAT in the lower extremity has been predominantly limited to plantar fasciitis [8,9]. and Achilles tendinopathy. Little has been published regarding the use of shockwave therapy for the treatment of a partially torn plantar plate. As such, conclusive evidence recommending EPAT for the treatment of plantar plate injuries is lacking. This case study details the rehabilitation of a partially torn plantar plate at the metatarsophalangeal joints 2-4 via shockwave therapy (EPAT) confirmed via serial MRI.

Case History

A 47-year-old female started experiencing pain at the metatarsophalangeal joint (MTPJ) 2-4 of her left foot as a result of extensive ambulation on cobblestone streets. Upon a forefoot evaluation, she reported a score of an 8 on the 0-10 numeric pain rating scale (NPRS), and complained of significant localized pain. Her initial clinical presentation consisted of pain on palpation at the plantar proximal phalangeal bases 2-4, and moderate swelling at the dorsal forefoot. Additionally, a gait evaluation revealed guarding, and limping on the affected limb.

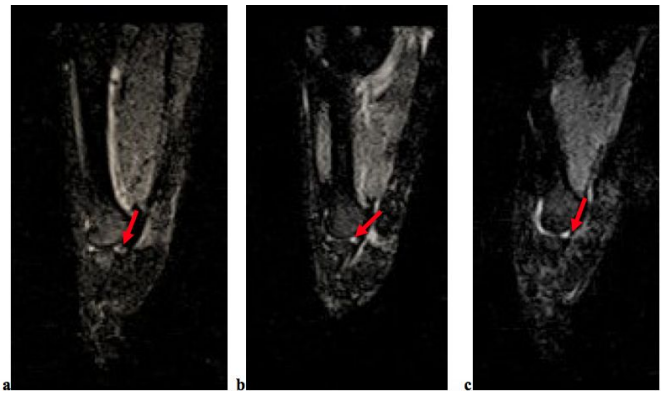

Figure 1 Partial thickness tear at the distal insertion of plantar plate at (a) second, (b) third and (c) fourth into proximal phalanx as indicated by hyperintensity (red arrow) on sagittal STIR images. Reactive joint effusions present.

Figure 2 Custom orthoses.

A subsequent MRI scan, evaluated by an external radiologist, revealed partial-thickness tears of the plantar plates of her lesser MTP joints 2-4, with reactive joint effusions at MTP joints 1-5 (Figure 1).

Figure 3 Alignment evaluation of patient weight bearing on orthoses.

Electing to avoid invasive surgical interventions, the patient was recommended EPAT as a primary treatment modality (with the addition of a custom molded orthosis (CMO) with metatarsal sling pad, as adjunctive treatments) (Figures 2, 3), which she agreed to.

Each treatment consisted of 3000 pulses at 2.8 bars. After the initial EPAT treatment, a significant reduction in pain was reported by the patient (5/10 on NPRS), and she was advised to avoid using NSAIDs and limit weight bearing on the affected area. After a second EPAT treatment, she was still unable to walk with standard footwear, however she reported a further decrease in her pain level to a 4/10 NPRS. After three EPAT treatments, three weeks after her initial treatment, she reported a 1/10 NPRS pain at rest, and 5/10 NPRS on ambulation. The clinical evaluation revealed that the joint was gaining stability, and on deep palpation, was less painful when compared to the initial examination. She was advised to transition to weight bear as tolerated (WBAT) while wearing the custom molded orthotics with metatarsal pads which were obtained at that time.

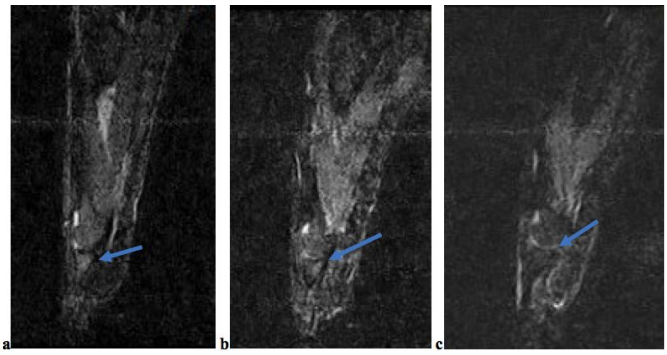

Figure 4 Lack of hyper intensity at insertion of plantar plate into proximal phalanx of (a) second, (b) third, and (c) fourth toe. Plantar plate insertion (blue arrow) shows homogeneous hypo intensity on sagittal STIR images.

At her seventh week follow-up appointment, and after five EPAT treatments, mild pain upon palpation was noted only at the second proximal phalanx with a NPRS score of 2/10, and no pain was elicited on deep palpation and passive range of motion (PROM) of 3rd and 4th MTP joint. Otherwise, she expressed a 0/10 NPRS at rest and upon ambulation. Upon clinical examination, the MTP joints 2-4 were stable on a dorsal drawer test, with no swelling present.

In the final follow-up examination, approximately two months after the first EPAT treatment, the patient disclosed that she was able to return to the same level of activity that she had before her injury. Additionally, when compared to her contralateral foot, the patient stated that she experienced neither pain nor edema. Furthermore, her second through fourth MTP joints were stable, and were not tender on palpation, nor on ambulation. A final MRI scan, obtained five and half months after the last EPAT treatment, revealed evidence of repair of her previously torn plantar plate, and improvement in the structural integrity of the plantar plate of her second through fourth MTP joint with no evidence of predislocation phenomenon (Figure 4).

Results

The patient was closely monitored on a weekly basis and progress was measured by a notable decrease in reported pain on the pain analog scale (0-10). Within seven weeks, the patient reported pain-free ambulation without stiffness and complete return to full normal activity. The pre-treatment sagittal Short TI Inversion Recovery (STIR) MRI images demonstrated increased intensity at the distal insertion sites of plantar plates into proximal phalanges at MTP

joints 2-4 (Figure 1). Partial-thickness tearing of plantar plates 2-4 with reactive joint effusions of MTPJs 1-5 was determined by an independent radiologist. The post-treatment MRI revealed homogeneous hypointense signal at the distal insertions of plantar plates 2-4 into proximal phalanges (Figure 4). Per an independent radiologist, no plantar plate defects or evidence of partial tears were noted on the post-EPAT MRI scan.

Discussion

This case report demonstrates the potential viability of shockwave therapy for the treatment of plantar plate tears and furthermore, advocates the need for medical providers to reevaluate the standard of care for such pathologies. By directly correlating a reduction in pain to the associated physiological process of healing, improvements could be evaluated. Thus, the course of healing of the previously torn plantar plate was determined using pain as a critical indicator. Subsequent MRI scans and the complete return to normal activity were objective findings that confirmed the full revitalization of the plantar plates. In our case study, therapeutic EPAT treatments facilitated the full recovery and rehabilitation of a previous plantar plate tear in just seven weeks (five treatments). The capacity of EPAT therapy to promote healing is evidenced by the significant reduction in total treatment time. The absence of additional or otherwise invasive operative procedures seems to substantiate the sole use of shockwave therapy for the treatment of plantar plate tears.

Despite notable findings presented in this case study, further investigation is required to fully appreciate the role of EPAT in the non-operative management of plantar plate injuries. Several notable factors likely influenced our results and must be addressed for the sake of future studies. As stated earlier, throughout this study, the physiological process of healing was monitored and determined by 3 main parameters: patient reported pain, pre- and post-treatment MRI scans, and the complete return to normal activity. However, these parameters are not without intrinsic flaws. Notably, the reduction in pain was monitored on a weekly basis by a patient reported score on a 10-point analog scale. However, not only is pain subjective, but the correlation between a reduction in pain and the physiological process of healing is widely debated. A reduction in pain may suggest healing but is not always a definitive diagnostic measure, as additional comorbidities may mask underlying pathologies. As such, to say that the plantar plate is healing because of a reduction in pain is very plausible, but still an assumption nonetheless. Conversely, an MRI would provide much more objective or definitive findings in regard to monitoring the healing process of the plantar plate. However, the timing and chronology in which the MRI scans were obtained in this study was less than ideal. The initial MRI revealed partial-thickness tears of the plantar plates of lesser MTP joints 2-4. A subsequent and final MRI, however, was not obtained until five and half months after seven weeks of EPAT treatment, which confirmed full resolution of the previously torn plantar plate. As such, the rehabilitation of the plantar plates and the healing process was almost exclusively monitored by clinical examination and the gradual reduction in reported pain. Ideally, MRI scans could have been obtained in shorter increments of two to three weeks to definitively confirm clinical findings (stability and reduction in pain). However, due to cost, MRI's were not obtained in such a manner.

The third parameter in which the rehabilitation of the plantar plates was determined, was the patient's complete return to normal activity. Again, this functional outcome measure, although appropriate, is patient reported, and therefore subjective: we cannot say with certainty that the patient had regained her pre-injury strength and mobility.

Another notable factor that must be addressed is the natural biological course of healing. Although less likely, we cannot rule out a "placebo effect" in which the patient reported a gradual decrease in pain scores which was attributed to EPAT therapy. The partial-thickness tears of the plantar plate may have followed a biological healing process, exclusive of the effects of EPAT therapy. This theory, however, is less likely due to numerous studies detailing the difficulty of treating plantar plate tears and their notable lack of resolution [4,10,11,12].

Despite such possible intrinsic shortcomings, this case report demonstrates the potential viability of shockwave therapy for the treatment of plantar plate injuries. Further studies must be performed to provide conclusive evidence recommending EPAT. In addition, guidelines such as the number of

treatments, the number of pulses per treatment, and/or the frequency of each pulse must be established. This unique case study was conducted by utilizing recent advancements in technology in hopes of challenging the current standard of care. Our findings were consistent with our goals to provide a better, modern, solution to an age-old debate between operative and nonoperative treatments of plantar plate tears.

Conclusion

The results of this case report demonstrate the viability of shockwave therapy for the treatment of plantar plate tears. Although further studies must be performed to provide conclusive evidence, our findings were consistent with our goals to provide a better, modern solution to an age-old debate between operative and nonoperative treatments of plantar plate tears. This unique case study was conducted by utilizing recent advancements in technology in hopes of challenging the current standard of care.

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