"Progressive Foot Peak Pressure Analysis after FHL Transfer for Chronic Retracted Tendo-achilles Tear" – A Pedobarographic Analysis of Normal Foot Versus Affected Foot.

ABSTRACT

Introduction

Foot pressure changes and morbidity after FHL transfer in chronic retracted TA tears have not been documented. The primary aim of our study is to analyze the peak pressure changes in various zones of the foot at each successive follow-up in the affected foot versus normal foot. The secondary aim is to determine FHL healing and Hypertrophy.

Methods

This is a prospective study of 46 patients who underwent FHL augmentation for retracted TA tears (between 2019-2022). Included TA tear >6 weeks duration and retraction >2.5cms. Excluded open TA tear,<6 weeks&retraction <2.5cms. Depending on the amount of retraction, FHL augmentation combined with TA repair/VY plasty/Turn-down-plasty.Functional outcome was analyzed with AOFAS hallux metatarsophalangeal scale. Pedobarographic analysis was done pre-operatively&at 3,6,9 months,1 year and at the final follow-up . Parameters studied-Forefoot peak pressure(FFPP), Hindfoot peak pressure(HFPP), Great toe peak pressure(GTPP), First Meta Tarso phalangeal peak pressure(MTPP), Area under the pedobarograph and Maximum pressure. At final follow-up MRI was done to assess FHL hypertrophy. Statistical analysis was done for these parameters using appropriate tests.

Results

Study involved 29male&17female patients, mean age-49.5 years(33-65years)&mean follow-up-26.8 months(14-38.4months). Mean AOFAS score increased from 46.04± 7.31preoperatively to 96.17± 3.22at the final follow-up($P < 0.01$). There was gradual improvement noted in all Peak pressures at subsequent follow-ups,and by end of 1-year foot pressures were comparable to normal side FFPP(8.02±3.8N/cm2 to 31.35±3 N/cm2,)HFPP (36.91±5.7 N/cm2 to 25.09±3.7 N/cm2),GTPP(30.78±13.01 N/cm2 to23.17±7.5N/cm2),MTPP(5.22± 2.64 N/cm2to23.3±9.6 N/cm2). Changes in pressures were statistically significant(<0.001). 6Patients had superficial wound infections healed with antibiotics.23 patients who participated in MRI showed a mean of 27mm muscle thickness& 7.1mm tendon thickness, complete incorporation of the FHL.

Conclusion

FHL transfer in Chronic Tendo-achilles tear yields good clinical outcomes and foot peak pressures and loading of the foot, though initially deranged, are restored and comparable to normal limb by the end of 1-year. GTPP

and MTPP pressure attributing to loss of FHL has shown progressive improvement at the final follow-up. FHL hypertrophy provides adequate strength to repair and restore foot pressures.

Keywords: Chronic Tendo-achilles tear, FHL transfer, pedobarogram, Peak pressure, great toe, forefoot, hindfoot, TA tear

Level of evidence III: Prospective comparative study (Normal versus operated foot)

"What are the new findings?"

- Though altered, peak pressures of the foot are restored and comparable to normal foot after FHL transfer for chronic retracted tendo-achilles tear.
- FHL hypertrophy is observed at the muscle thickness and the distal tendon.

Introduction

Chronic tendo-achilles (TA)rupture includes tears that usually present 4-6 weeks after injury[1]. 25% of acute TA tears progress into chronic tears due to neglect or missed diagnosis. Management of chronic tears is challenging, owing to the contraction of the tendon after injury leading to retraction of the tendon. Inherent poor vascularity and the gap after debridement accentuate the problems during the surgical intervention[2].

Various surgical options are described for chronic tendo-achilles ruptures depending on the duration of injury and amount of retraction. These include an end-to-end repair, V-Y lengthening of gastrosoleus, turn-down-plasty, peroneus brevis transfer (PB), single and double incision flexor hallucis longus transfer(FHL) and use of free tendon graft autografts [3,4,5].

FHL transfer or augmentation is commonly preferred, as it is in phase muscle to the gastrocnemius and soleus muscles. Its axis of contraction is in line with the tendo-achilles. Also, it is close to the tendo-achilles enabling its harvest through the same incision. Further, the Master Knot of Henry allows for the maintenance of some flexion strength to the great toe after FHL tenotomy. Suturing the FHL to the Achilles tendon, there is a theoretical advantage of increased blood supply to tendo-achilles and better healing rates [6], [7].

The potential morbidities associated with FHL transfer include loss of 1st MTP and interphalangeal (IP) joint and cock-up deformity of the great toe. This decrease in strength and diminished push-off can cause alteration in foot pressures during gait and affect balance [8]

Pedobarogram is a dynamic recording of foot pressure during the stance phase of the gait cycle. Parameters like peak pressure, force, area in contact with ground and duration of stance phase can be gathered from the pedobarogram. It is well documented that patients with tendo-achilles insufficiency have increased calcaneal loading along with calcaneal gait. Serial recording of foot pressures after the surgical repair enables us to record the pressure changes in the forefoot during push-off after FHL transfer.[9]

Three studies have reported pressure changes in the foot after FHL transfer. Coull et al. [10] reported on 16 patients undergoing FHL transfer using single-incision and double-incision techniques. Hahn et al.[11] reported using the two-incision technique in 13 patients. Both observed clinical weakness of the hallux. Richardson et al. l [12] studied forefoot pressures in 28 patients undergoing FHL transfer. However, none of the studies has a serial recording of pressure changes after surgery, and the implications of foot pressure changes after FHL transfer need to be studied. Our study aims to serially document the various pressure changes in the foot after FHL transfer and analyze the pattern of pressure changes in the forefoot and hindfoot at subsequent follow-up. We hypothesize that foot pressure changes restore normalcy comparable to the opposite side.

Materials and Methods

The prospective study was carried out between 2019 and 2022 after obtaining approval from the Institutional review board (IRB) ethical committee (IRB Application No: 2019/11/02 Regn: ECR/1146/inst/TN/2018). All the patients with TA tears of more than 6 weeks duration and retraction of more than 2.5 cm were included and excluded open TA tears, with less than 6 weeks, retraction less than 2.5 cm, patients with neuropathic foot and bilateral TA injury. 58 patients were enrolled in the study, and 12 patients were lost to follow-up/complete data not available for the analysis. Totally 46 patients (46 feet) who underwent FHL augmentation for chronic TA tear along with TA repair or V-Y plasty /turn-down-plasty with a minimum one year follow-up were included in the study (Figure 1). Pre-operatively, patient demographic details like age, BMI, and duration of injury were documented, and all the patients were clinically assessed for a palpable tendo-achilles gap, gait, tip toe standing test and Thompson's test.

Surgical technique

All cases were operated on using a posterior midline approach. The tendon stump was debrided until all of the degenerated tendon and retrocalcific spurs were removed, followed by excision of the Haglund bump in all cases. The retraction was measured after debridement. FHL was identified and isolated through the same approach. In TA tears with retraction up to 2.5-3.5 cm, FHL augmentation was done along with tendo-achilles repair owing to ameliorate tight repair due to delayed presentation. In patients with 3.5-5 cm of retraction of the tendon stump, the tendon fails to slide down to the insertion site despite sustained traction, for which V-Y plasty combined with FHL augmentation(Figure 2) and repaired with a 5mm suture anchor. V-Y plasty yields about 1-1.5cm in length (Figure 2A). In patients with a retraction gap of >5 cm, turn-down-plasty was done along with FHL transfer (Figure 2B) fixed into the calcaneum with an interference screw.

Postoperatively, the operated leg was immobilized with the below-the-knee cast, with a window made at the level of the wound site for regular dressings and suture removal at the end of 2nd week. The patient is advised to remain non-weight bearing for 6 weeks and then allowed for partial weight-bearing using Multicellular polyurethane (MCP) footwear with heel raise. Gentle ankle range of movement (ROM) was also started, then progressed to full weight-bearing walking by the end of 8 weeks.

Pedobarographic foot pressure measurements were conducted using EMED- Q (4 sensors/cm2, 100 Hz) (Novel GmbH, Munich, Germany) (Figure 3A). The system allows for static and dynamic plantar pressure measurements and consists of a color printer, monitor, pressure-sensitive platform and power supply. Each sensor has dimensions of an area of 475x320 mm. The pressure range is 1-720 N/cm^2, and the resolution is 1 N/cm^2 The dimensions of the platform are 700x403x15.5mm, and the accuracy related to the foot is ±5 %. Patients walked along a 6 m walkway at their self-selected pace (Figure 3B) and were asked to do trial walks across foot plates until they were comfortable ambulating with a normal gait. The pedobarograph was divided into five anatomical regions: the distal phalanx of the great toe area, forefoot,1st metatarsophalangeal (MTP) area, midfoot and hindfoot area. We used only the highest pressure point (Peak pressure) in the region of interest. Pressure parameters studied included- forefoot peak pressure(FFPP), Hindfoot peak pressure(HFPP), Great toe peak pressure(GTPP), First metatarsophalangeal peak pressure(MTPP), Area under the Pedobarograph and Maximum pressure (Figure 4). The contralateral foot was chosen as a control.

The pedobarographic study was done pre-operatively and at each follow-up period at 3,6,9 months,1 year and at the final follow-up. Functional outcome was analyzed with AOFAS hallux metatarsophalangeal scale [11]

MRI was done for both legs after one year during the final follow-up to assess for incorporation of the FHL and to measure the thickness of the FHL muscle and tendon following transfer (Figure 5). FHL muscle thickness was assessed 4 cm above the ankle joint level and compared with unaffected size for calculating a change in thickness [14]. FHL tendon thickness was measured at the level of the ankle joint. Two independent blinded observers recorded these measurements (musculoskeletal fellowship-trained radiologist and sports medicine fellow) 6 weeks apart and calculated intra-observer reliability.

Statistical methods

Data were entered into a Microsoft Excel data sheet and analyzed using SPSS 22 version software. Average values were considered, and Categorical data was represented in the form of Frequencies and proportions. The chi-square test or Fischer's exact test (for 2x2 tables only) was used as a 'test of significance' for qualitative data. Continuous data were represented as mean and standard deviation. An Independent t-test was used as a 'test of significance' to identify the mean difference between the normal and operated sides. Paired t-test was used to compare the difference between preoperative and follow-up means values. Intraclass correlation coefficient(ICC) was used to check for agreement between two observers for MRI measurement.

Power of the study

It is estimated to know the adequacy of the Sample Size and determined by using the difference in Mean FFPP between the Normal and affected sides from the pilot study done in our institute as 29.8 ± 3.27 and 32.3 ± 3.87. Using these values at a 95% Confidence limit and 90% power sample size of 41 was obtained in each group using the formula below and Med calc sample size software. With a 10% nonresponse sample size of 41 + 4.1 ≈ 45 cases will be included in each group.

Sample Size Estimation Formula:

$$N = \frac{2\, SD^2 (Z_{\alpha/2} + Z_{\beta})^2}{d^2}$$

Where $Z_{\alpha/2}$ is the critical value of the Normal distribution at $\alpha/2$ (e.g. for a confidence level of 95%, α is 0.05, and the critical value is 1.96), Z_{β} is the critical value of the Normal distribution at β (e.g. for a power of 90%, ß is 0.2, and the critical value is 1.28), SD is the standard deviation from previous study population variance, and d is the difference between two mean

P value (Probability that the result is true) of <0.05 was considered statistically significant after assuming all the rules of statistical tests.

Results

Patient demographic data are summarized in table 1. Our study included 29 males and 17 females. The mean age of the study population was 49.5 years(33-65 years), and the mean follow-up was 26.8 months(14-38.4months). The mean duration from injury was 16.4 weeks (6-52 weeks). The study consisted of 37 cases of tendo-achilles repair with FHL augmentation,4 cases of V-Y plasty and 5 cases of turndown plasty and FHL augmentation. All were operated by single incision posterior approach for the FHL transfer technique. The mean AOFAS score increased from 46.04± 7.31preoperatively to 96.17± 3.22 at the final follow-up (P < 0.01). Each patient, at their last follow-up, was able to perform repetitive single heel rise on the involved limb and could walk without a visible limp.

Mean Peak pressures values were compared to preoperative peak pressures showed gradual improvement in all the peak pressure parameters at subsequent follow-ups: FFPP(8.02±3.8N/cm2 to 31.35±3 N/cm2,)HFPP (36.91±5.7 N/cm2 to 25.09±3.7 N/cm2),GTPP(30.78±13.01 N/cm2 to 23.17±7.5N/cm2),MTPP(5.22± 2.64 N/cm2to23.3±9.6 N/cm2)MAX FORCE (831.48±76N to 858.88±85N) area under pedobarograph (126±12.8cm2 to 128.91±11.08cm2).The FFPP,GTPP, and MTPP showed an increasing trend until the final follow-up, whereas HFPP gradually decreased to normal (Figure 4A). Changes in pressures were statistically significant(<0.01) (Table 2).

When mean Peak pressures values were compared to mean values of the unaffected(normal) foot FFPP and HFPP were comparable to the normal side by the end of the final follow-up, 1st MTP pressures returned to normal by 9months and further improvement was noted till final follow up. GTPP improved over a period, and a statistically significant difference ($p<0.01$)was still observed at the end of the last follow-up when compared to normal feet (Table 3). The 'area of pedobarograph' and maximum pressures didn't reflect any significant change pattern when compared to mean values.

23 patients who participated in a follow-up MRI showed a mean of 27mm muscle thickness and 7.1mm tendinous thickness. Which accounts for a 24% and 22% increase in muscle and tendon thickness, respectively; thus, hypertrophy of the FHL was evident. Complete incorporation of the transferred FHL tendon was noted in all 23 patients. The intra-observer difference for thickness measurement of tendon and muscle post FHL transfer was not significant (0.12 and 0.11). 6 Patients had superficial wound infections healed with antibiotics. No patient had any sural nerve injury or deep vein thrombosis. Patients were able to return to daily life activity levels without difficulties. None of the patients had re-tear/failure to heal

Discussion

The most important finding from our study is that foot peak pressures gradually increased over the period of time, including GTPP, which is significant when compared to pre-operative mean values(TABLE 2). Also, FHL incorporation and hypertrophy of muscle and tendon after its transfer are evident.

Pedobarogram is a widely used tool for quantitatively evaluating plantar pressure distribution in the diagnostics and management of foot ailments. However, there is a lack of standardized protocol for analyzing pedobarogram [15]; Hahn et al. [11] have summed the pressures in the region of interest to depict the total pressure, coull et al. [10] have used average values. The reliability of the plantar pressure measurement is influenced by the technical aspect of the equipment used, regions of the foot analysis, the number of trials collected, and the method used to compute the data.[16] peak pressure is the maximum pressure measured by the sensor over the entire rolling process. Thus, choosing the peak pressure values for analysis would reveal the patient's ‘maximum force’ and the foot's precise morbidity.

We serially documented the gait pattern and pressure distribution changes after surgery. The initial calcaneal loading gait with low FFPP and high HFPP gradually restored to normal gait, with patients loading the forefoot during the heel-off phase of the gait cycle (Figure 3D). It is evident from our study that the pressure exerted during forefoot loading subsequently increases (FFPP)after FHL transfer, which becomes comparable to normal foot and statistically, no significant difference ($p<0.56$)is noted at the final follow-up. The mean GTPP was reported to have a significant difference ($p<0.01$) compared to normal feet at the final follow. However, this did not reflect considerable morbidity in the study population. The FHL strength necessary for a day-to-day function is likely accommodated by the flexor hallucis brevis or from the preserved interconnection between FDL and FHL in the midfoot at the Master Knot.[17,18]

All the patients could do routine daily activities without discomfort and return to their previous work. This is because of good restoration of tendo-achilles tension; otherwise, short and tight tendo-achilles repair increases the peak plantar pressures on the forefoot and causes an early heel rise during the stance phase of the gait cycle [19]. The ‘maximum force’ (vertical force measured by the sensor over the entire roll-off process) and the ‘area under pedobarogram’ are not significant in our study. These parameters play a vital role in bone deformities and neuropathic foot to predict the development of trophic ulcers[20]

Despite FHL transfer being a very commonly done procedure, there are very few studies done to document pressure changes after surgery. Hahn et al. [11]reported using the two-incision technique in 13 patients and noted clinical weakness of the hallux and decreased pressure under the great toe, which was compensated by significantly increased loading of the central and lateral forefoot structures after the transfer compared to the normal foot. However, recent studies [20,21]have found that peak pressure in the forefoot is lateral to 1st MTP in normal gait; hence we analyzed the 1st MTP region separately. From our study, mean first MTP pressures are always smaller than mean FFPP both in affected and non-affected limbs; we cannot conclude that pressures lateralized in FHL transfer. Also, Coull et al. [8]studied pressure changes in 16 patients undergoing FHL transfer using both single and double incision techniques and did not find any decrease in pressure at the first metatarsal head nor a significant transfer of pressure from the first joint laterally to the second MTP joint which is comparable to our results

Richardson et al. [12]reported pressure changes in 22 patients who underwent FHL transfer using a single incision technique. They noted significantly decreased pressure under the distal phalanx and weakness of the hallux, which resulted in minimal patient morbidity concerning hallux function. This finding was similar to our results; we could also predict the time for FFPP and GTPP restoration to near normal.

A meta-analysis conducted by Jirun Apinun et al. [22] was to determine the clinical outcomes of chronic Achilles tendon rupture treated with FHL transfer and FHL augmentation. He concluded that FHL augmentation has higher functional outcomes, and this was comparable to our study (AOFAS score improved from 46.04± 7.31preoperatively to 96.17± 3.22 at final follow-up) ($P < 0.01$). Clinically all patients could do a tiptoe standing test by the end of six months.

MRI analysis showed significant hypertrophy after the FHL transfer. Maria Oksanen et al. [14] noted a mean hypertrophy of 52 % of the FHL muscle, indicating a strong adaptation capacity of this muscle after FHL transfer in a situation where the function of the gastro-soleus complex was severely impaired. Our study shows that mean hypertrophy of 24% of FHL muscle and a 22% increase in tendon thickness indicates adaptation of both tenocytes and myocytes to the stress after the transfer. Oksanen et al. case series involved isolated FHL transfer without TA repair; hence a higher percentage of hypertrophy was noted, whereas in our study majority of FHL transfer was associated with TA repair.

Limitations of the study

The study involved the general population who mostly does farming and household work; these results cannot be assumed identical for the athletic population. In this study, we could only document pressure changes after FHL transfer; however, objective documentation of gait using a digital motion capture system is essential for confirmation of restoration of gait without any asymmetry on both sides. Also, evaluation of the strength of great toe flexion by employing a dynamometer is required for quantitative documentation of great toe flexion strength. Long-term follow-up is necessary to note the return of GPPP to normal. Intergroup analysis was not possible due to less number of patients.

Conclusion:

FHL transfer in Chronic Tendo-achilles tear yields good clinical outcomes, and foot peak pressures and loading of the foot, though initially deranged, are restored and comparable to normal limb by 1 year. GTPP and MTPP pressure attributing to loss of FHL has shown progressive improvement at the final follow-up. FHL hypertrophy provides adequate strength to repair and restore foot pressures.

No conflict of interest.

Acknowledgements: Our hospital Physiotherapist who has collated all the clinical scores, documented into digital hospital records.

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Figure legends:

Figure 1 -PICO Flow chart (P-Population, I-Intervention, C-Comparison, Outcome).

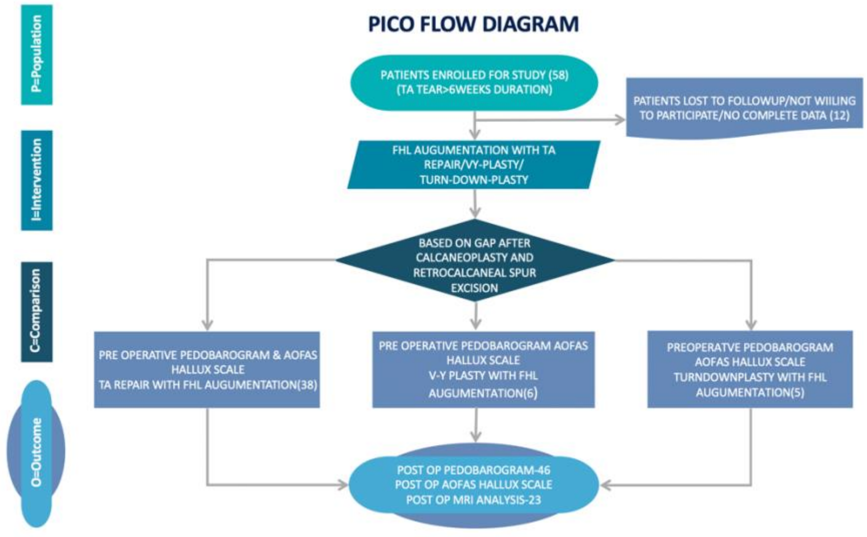

Figure 2-A Intra operative picture showing tenon retraction of 3.5cms, VY plasty yields 1.5cms of length and FHL augmentation and TA repair with suture anchor, 2B displaying tenon retraction of around 9.5cms and intra operative picture picture of FHL transfer with turn-down-plasty fixed by Bio-screw.

Figure 3-A EMED platform where pressures of the foot are recorded in the computer, 3B-Patient walking on the platform and instructed to walk first with normal foot on the platform and then in second attempt with affected foot on the platform, 3C- Peak pressure values in different zones of foot, 3D- Comparison of serial foot pressures in preoperative period and at each follow-up, depicted by color code shown in the scale by the side of the foot print (unit of N/cm^2).

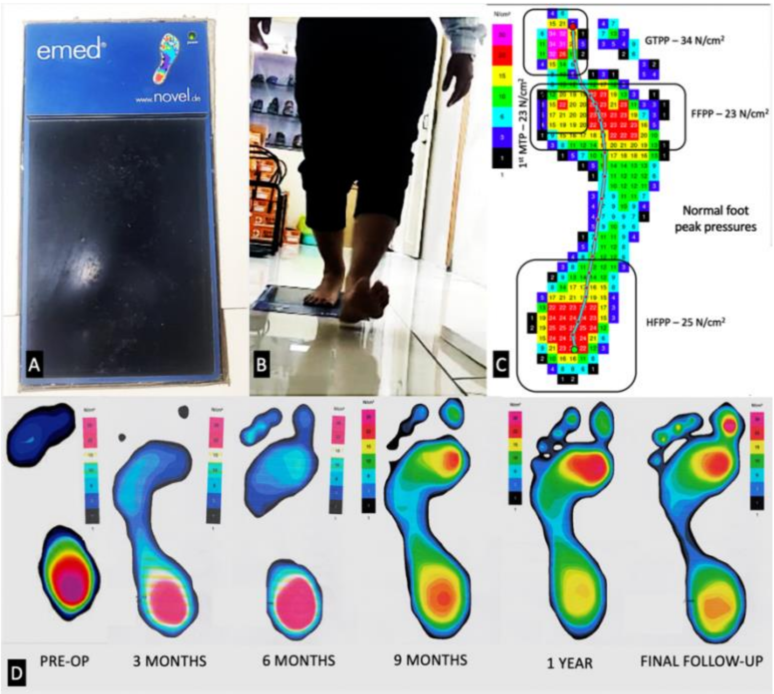

Figure 4 -A Box whisker plot showing entire data set of patients preoperative and at each follow up (x mark in the box-plot suggests mean, line indicates meridian. The blue arrow in the chart shows increasing trend in mean values of -FFPP, GTPP, 1stMTPP, AOFAS score and Decreasing trend for HFPP. 4B- Comparison of normal Peak pressures versus final follow-up- 26 patients have FFPP more than normal foot, HFPP is comparable to normal foot, GTPP are less than normal foot in all patients and 29 patients have 1st MTP is more than than normal foot. (GTPP -Great toe peak pressure, 1st MTPP -First Meta Tarso phalangeal peak pressure, HFPP -Hindfoot peak pressure, FFPP- Forefoot peak pressure, AOFAS-American orthopedic foot and ankle society hallux metatarsophalangeal scores).

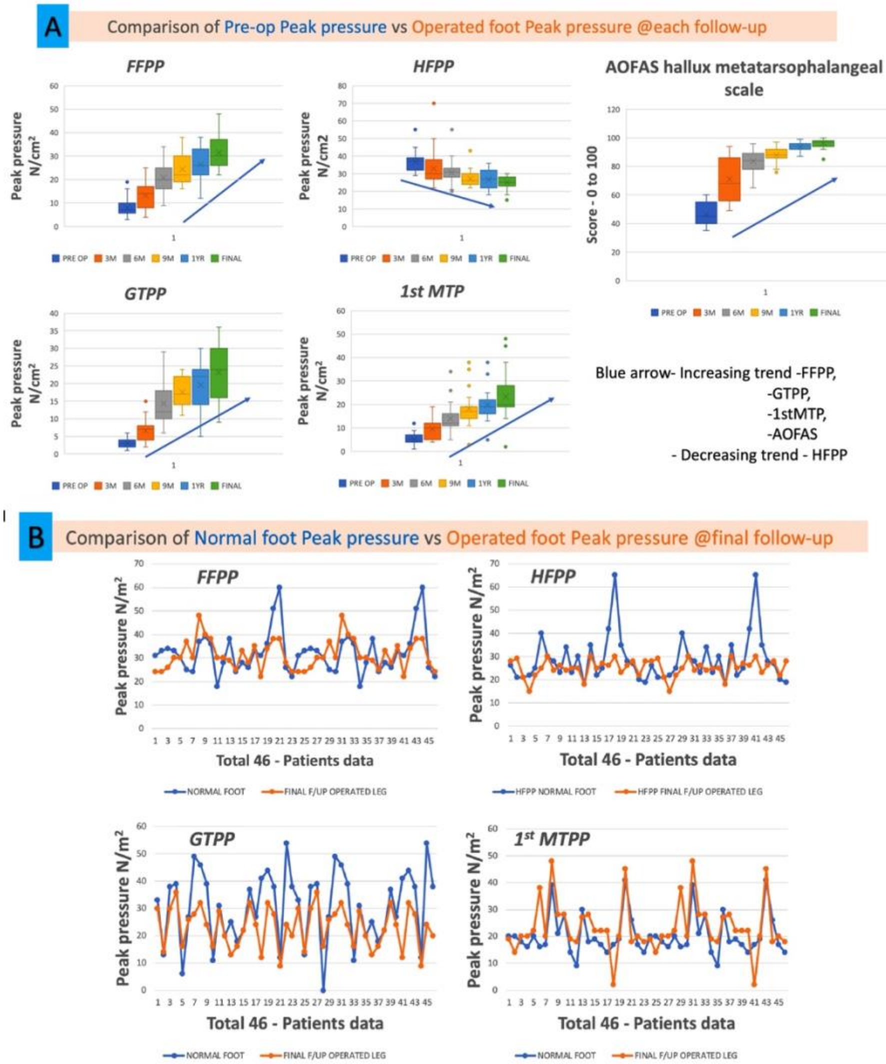

Figure 5- MRI of patient showing FHL muscle and tendon thickness depicting- tendon and muscle hypertrophy and good incorporation of the FHL into calcaneum after at 1 year follow.

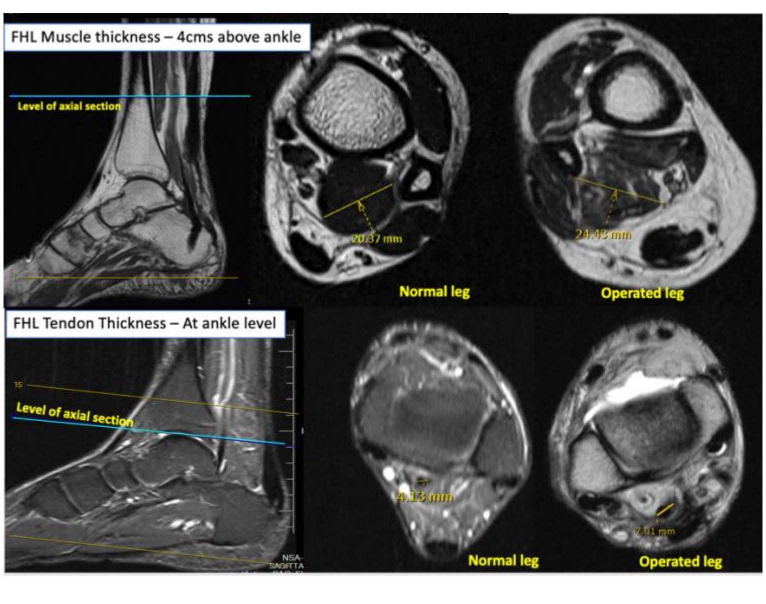

Table legends:

Table 1: Patients' demographic data and time to surgery.

	FHL transfer (n=46)
Male/female,	29/17
Age, mean(range), years	49.5 years (33-65years)
BMI(kg/m^2)	26.8+/-.2.2
Side, Right: left	27:19
Mechanism of injury	Trivial fall-23 Forceful squatting-18 Miscellaneous-6
Time to surgery from injury	16.4weeks (6-52weeks)
Mean follow-up months,(range)	26.8months (14-38.4months)
TA tear no of patients 2.5-3.5cms **3.5-5cms** **>5cms**	37 4 5
Co-morbidities	Diabetes-9 Hypertension-6 hypothyroidism-4

AOFAS (hallux metatarsophalangeal scale) mean **Preoperative score** **Final follow-up**	46.04± 7.31 96.17± 3.22
MRI mean measurement of FHL augmented tendon(n=23) **- Muscle thickness 4cm above ankle level (normal: operated)** **- Tendon thickness at ankle joint level (normal: operated)**	21mm:27mm(ICC<0.12) 5.8mm:7.1mm (ICC<0.11)
Complications	Superficial infection-6 Wound dehiscence -2

Below tables – table 2 and table 3 as supplementary Data

TABLE 2-Comparing mean of Peak pressure parameters at each follow up with Preoperative values (GTPP - Great toe peak pressure, 1st MTPP -First Meta Tarso phalangeal peak pressure HFPP -Hindfoot peak pressure, FFPP- Forefoot peak pressure)

	PREOP (MEAN±SD)	3Months(MEAN±SD)	P-value	6Months(MEAN±SD)	P-value	9Months (MEAN±SD)	P-value	1YR(MEAN±SD)	P-value	FINAL(MEAN±SD)	P-value
GTPP	3 +/-1.5	6.5+/-2.9	0.01	14.3 +/-5.8	0.01	17.6+/-4.3	0.01	19.5+/-6.4	0.01	23.17 +/- 7.5	0.01
1stMTP	5.2 +/- 2.6	9.6 +/- 4.4	0.01	14.0+/- 6.1	0.01	18.2 +/- 7.3	0.01	19.7+/- 6.4	0.01	23.39 +/- 9.6	0.01
HFPP	36.9+/- 5.7	32.8+/- 10.2	0.04	30.6 +/-7.0	0.01	27.1 +/-4.9	0.01	26.6+/- 4.8	0.01	25.09 +/-3.7	0.01
FFPP	8.0 +/-3.8	13.1+/- 5.5	0.01	20.7+/- 6.8	0.01	24.3+/- 6.5	0.01	26.4+/- 6.8	0.01	31.35+/- 6.3	0.01
AREA	126 +/- 12.8	114.6+/- 16.0	0.01	124.2+/- 18.8	0.64	125.9 +/-13.6	0.97	125.8+/-15.2	0.96	128.91 +/- 11.0	0.27
MAX FORCE	831.4 +/-76.7	809.7+/-72.0	0.12	850.3+/- 104.6	0.28	823.0+/- 70.1	0.62	850.2+/- 102.7	0.34	858.22 +/- 85.9	0.92

TABLE 3- Comparing mean of Peak pressure parameters at each follow up with unaffected foot (GTPP -Great toe peak pressure, 1st MTPP -First Meta Tarso phalangeal peak pressure HFPP -Hindfoot peak pressure, FFPP- Forefoot peak pressure)

	NORMAL (MEAN±SD)	3Months MEAN±SD)	P-value	6Months (MEAN±SD)	P-value	9Months (MEAN±SD)	P-value	1YR (MEAN±SD)	P-value	FINAL (MEAN±SD)	P-value
GTPP	30.7±13.0	6.5±2.9	0.01	14.3 +/-5.8	0.01	17.6+/-4.3	0.01	19.5+/-6.4	0.01	23.17 +/- 7.5	0.01
1st MTPP	20.43±7.6	9.6 ±4.4	0.01	14.09+/- 6.1	0.01	18.2 +/-7.3	0.16	19.7+/- 6.4	0.65	23.39 +/- 9.6	0.10
HFPP	28.6±10.1	32.8±10.2	0.05	30.61 +/-7.0	0.28	27.1 +/-4.9	0.36	26.6+/- 4.8	0.22	25.09 +/-3.7	0.02
FFPP	32.3±9.1	13.1±5.5	0.01	20.78+/- 6.8	0.01	24.3+/- 6.5	0.01	26.4+/- 6.8	0.01	31.35+/- 6.3	0.56
AREA	128.3±15.1	114.6±16.0	0.01	124.26. +/- 18.8	0.25	125.9 +/-13.6	0.41	125.8+/-15.2	0.42	128.91 +/- 11.0	0.85
MAX FORCE	855.7±104.7	809.7±72.0	0.01	850.3.+/- 104.6	0.80	823.0+/- 70.1	0.80	850.2+/- 102.7	0.79	858.22 +/- 85.9	0.90