

Abstract

Evaluation of pain often relies on subjective patient reported outcomes (PROs) such as the Numerical Rating Scale. Supplementing such measures with objective endpoints can provide a deeper assessment of acute and chronic pain. In the present study, we evaluate quantitative gait analysis using a podiatric walkway that records pressure measurements and spatiotemporal parameters during a full gait cycle. We recruited healthy volunteers and patients with symptomatic Morton neuroma pain (MN). Consented participants completed questionnaires assessing pain, physical functioning, and quality of life. We hypothesized that patients with MN pain would have abnormal gait and altered pressure loading from the affected foot detectable using gait analysis. Data show significant differences in measurements taken from the affected feet of MN patients, supporting gait analysis as an informative adjunct to subjective pain assessments and a potentially useful tool in measuring response to novel interventional treatments. This work will inform future studies that seek to initiate treatment with the non-opioid interventional analgesic resiniferatoxin (RTX) for MN pain and other painful neuropathic conditions.

Gait analysis for functional outcomes in interventional pain management

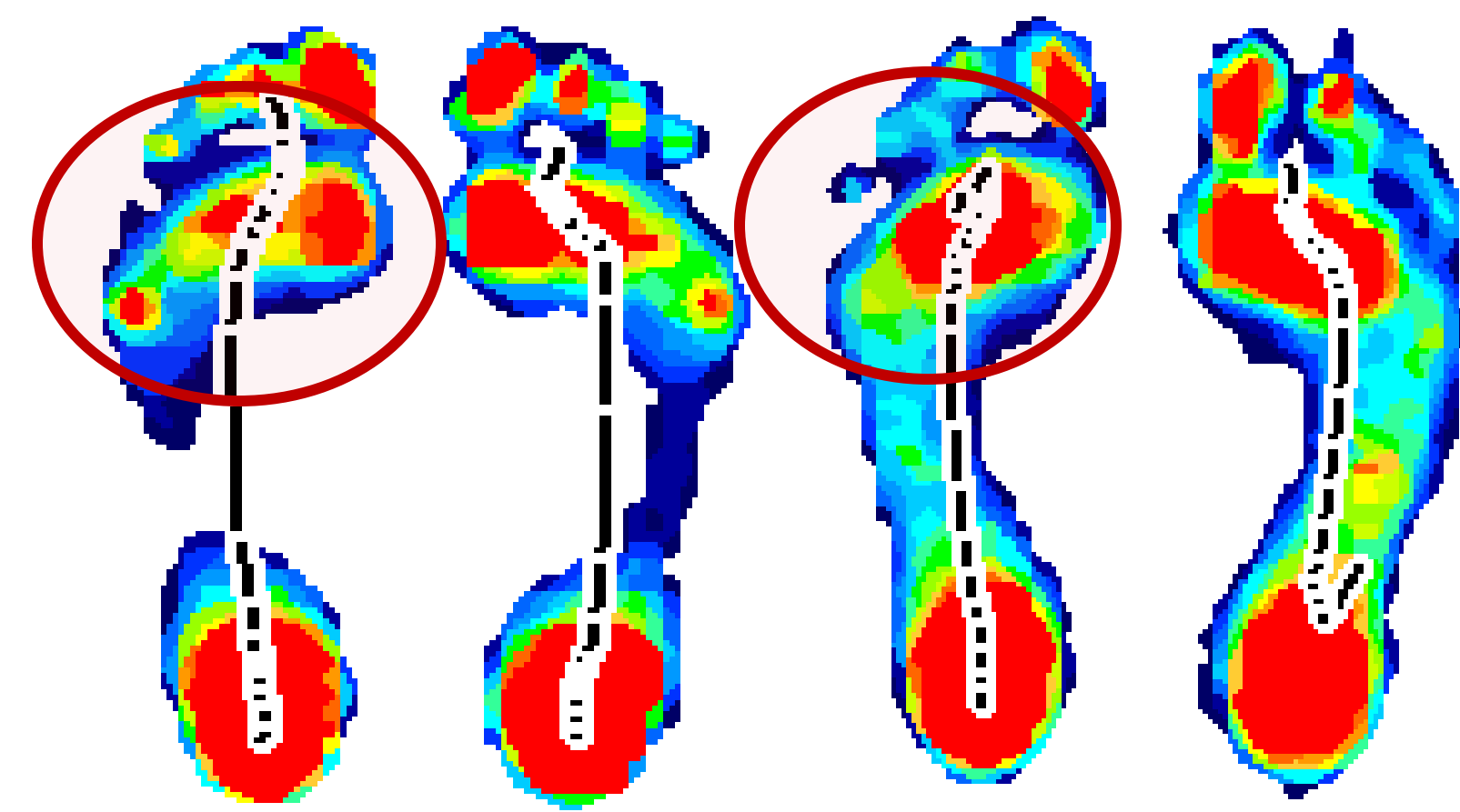


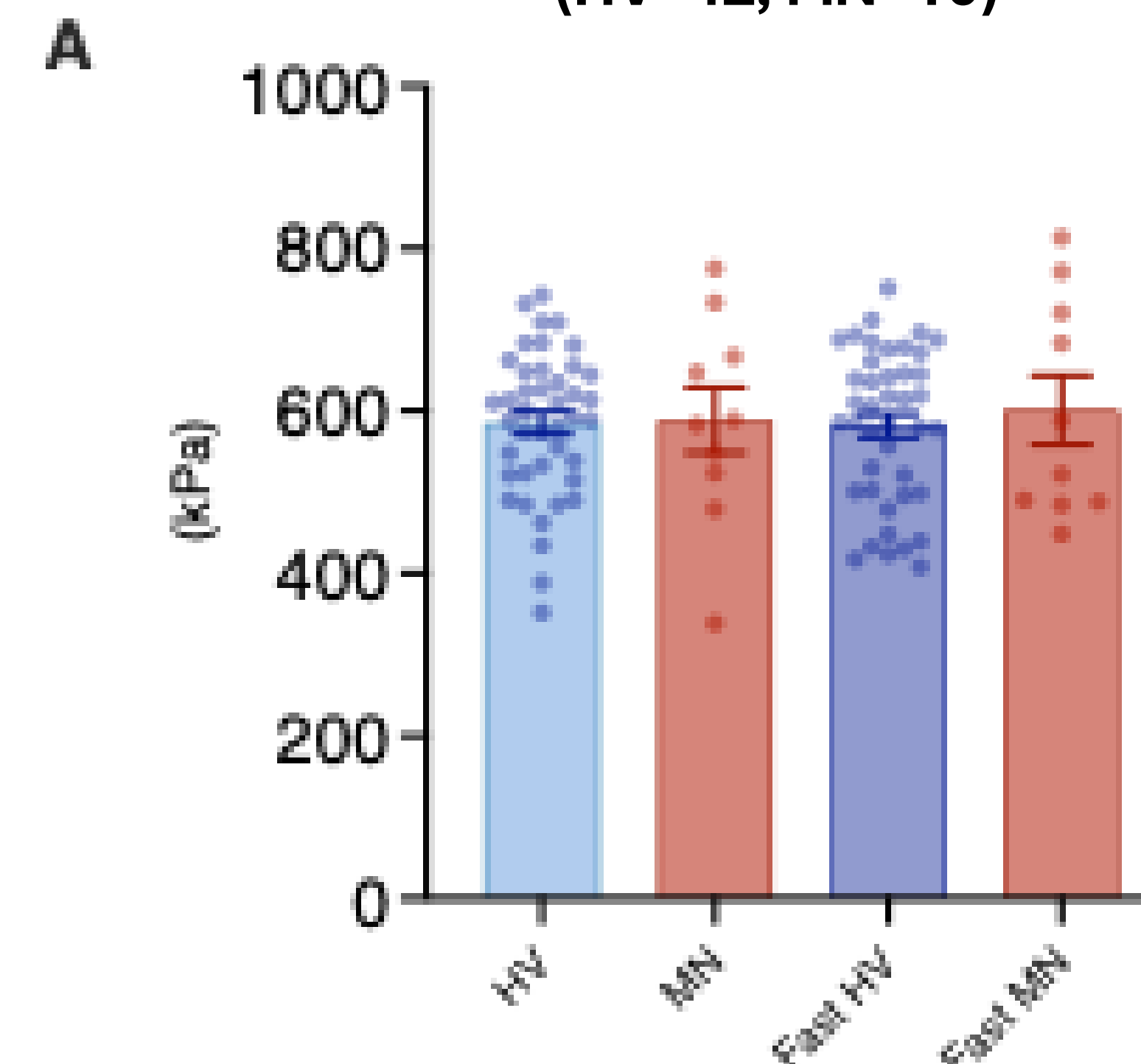
Figure 3. Pressure heat mapping of 2 MN patients with L-sided lesions. Affected feet show a smaller area of maximal plantar pressure (red) compared to non-affected feet.

We expect to find lower maximal pressure under the metatarsals of patients with symptomatic MN pain.

- Composite frames show the highest pressure experienced by each part of the foot during all foot strikes.
- Pressure data were collected from software-templated regions; Metatarsal was chosen for analysis.

Results

Metatarsal Peak Pressure Comparison (HV=42; MN=10)



Spatiotemporal Comparison (HV=42; MN=10)

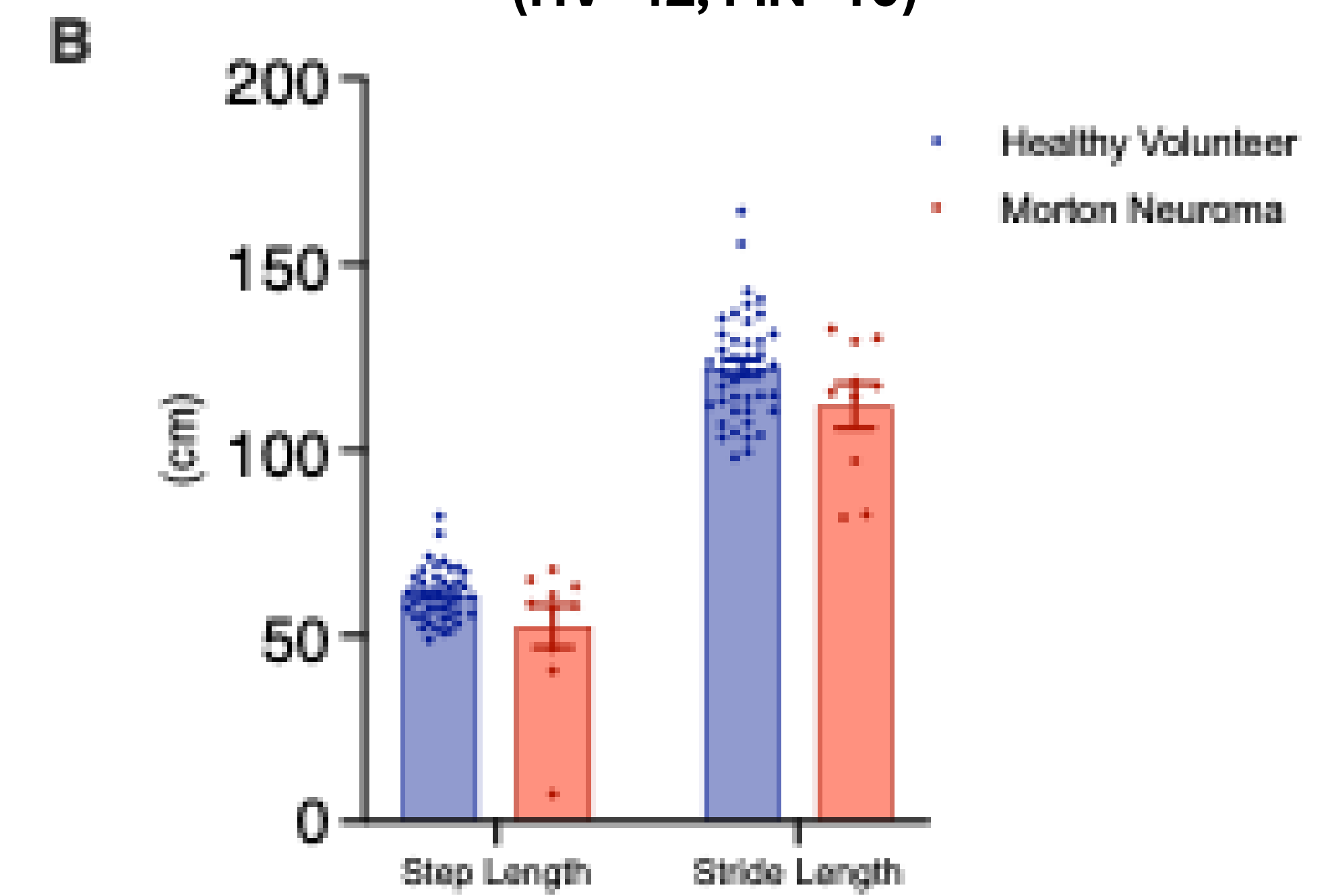


Figure 4A. Comparison of metatarsal peak pressure between all HV feet and symptomatic MN feet. Significant between-group differences in MPP were not detected at any speed. **4B. Comparison of distance variables between all HV feet and symptomatic MN feet.** MN patients demonstrated reduced step length ($p=0.01$) and stride length ($p=0.03$).

Recruitment of study participants

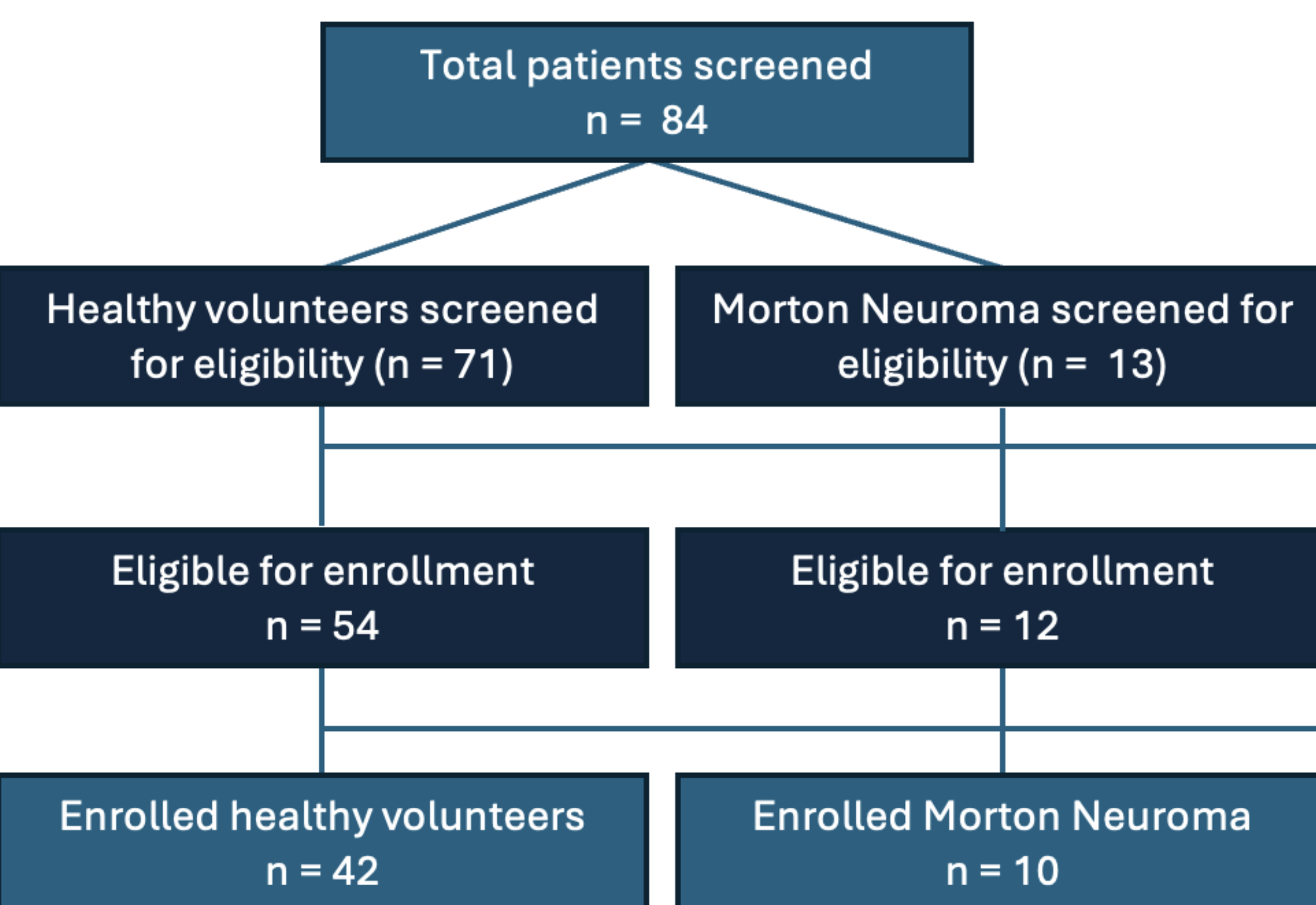


Figure 1. Participant recruitment flow chart. Participants were recruited from the local community.

Excluded (N = 17 HV; N = 1 MN)

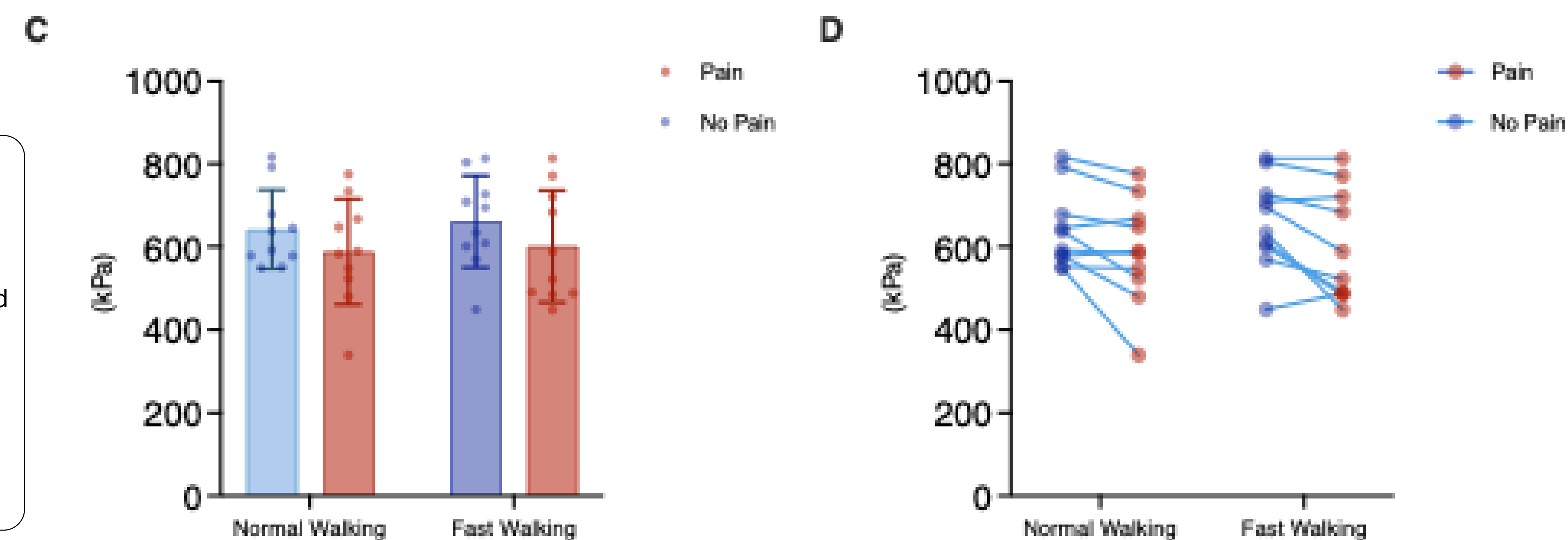
- Pain not due to Morton Neuroma (N = 12 HV)
- Non-painful condition affecting gait (N = 5 HV)
- Resolution of pain (N = 1 MN)

Lost to follow-up (N = 12 HV; N = 2 MN)

Figure 4C. Pooled averages for metatarsal peak pressure of Pain and No Pain feet in MN patients, at different speeds. We observed significantly lower MPP in the affected feet of MN ($588+40.23$ kPa) compared to non-affected MN feet ($642.16+30.17$ kPa); $p=0.02$.

Figure 4D. Pairing of Pain and No Pain sides. MN patients demonstrate variability of gait patterns, which may reflect individual differences in compensatory mechanisms.

Metatarsal Peak Pressure Morton Neuroma (N=10)



Study visit flow

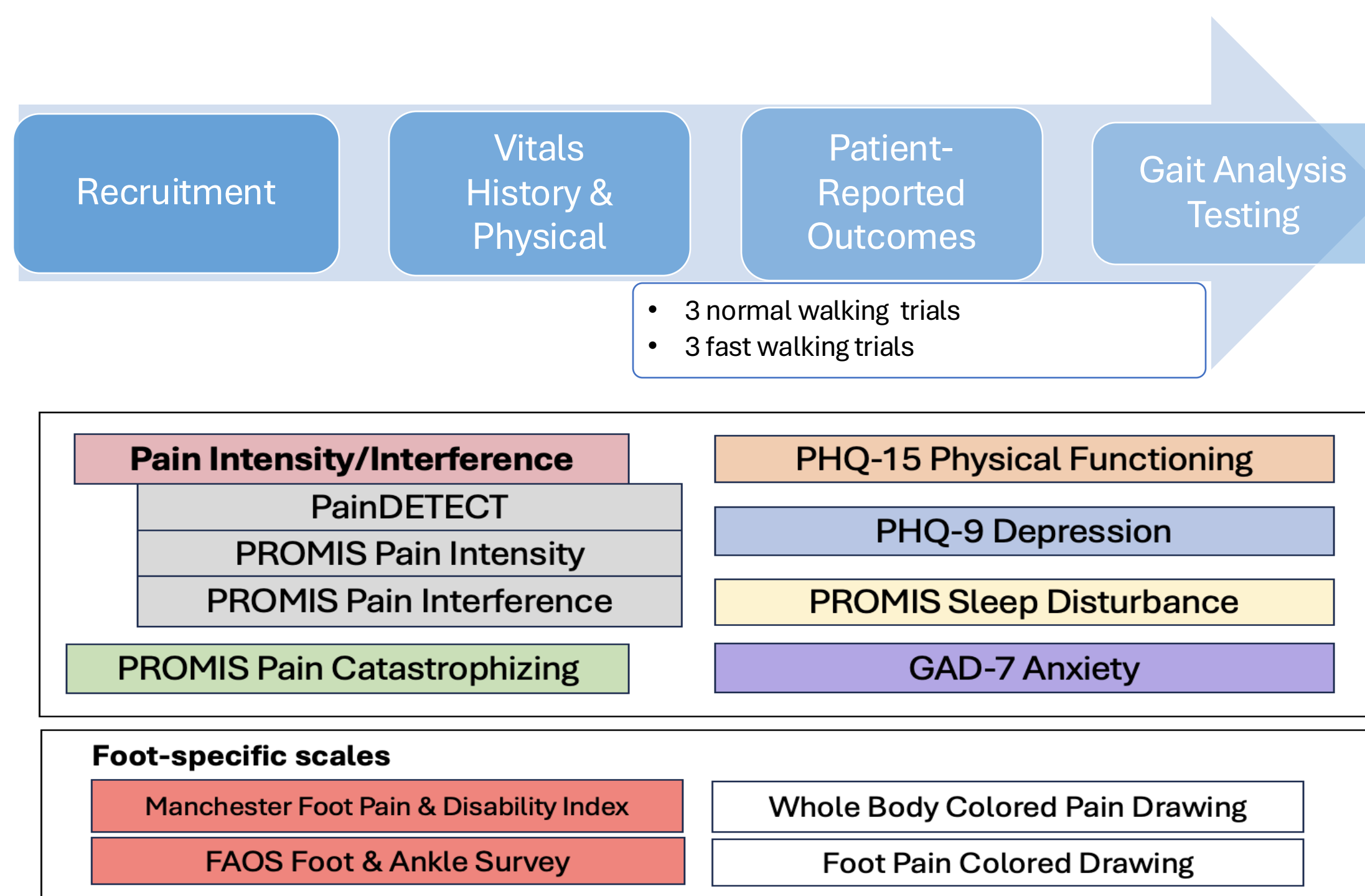


Figure 2. Patient Reported Outcomes. Questionnaires were used to confirm the absence of painful conditions in healthy volunteers and quantify pain severity and disability in pain patients.

Patient demographics

	Healthy (N=42)	Morton Neuroma (N=10)	Total (N=52)
Median age — yr (range)	32 (20-73)	57 (35-72)	40 (20-73)
Age group — no. (%)			
20-39	24 (57.1)	1 (10)	25 (48.1)
40-59	14 (33.3)	4 (40)	18 (34.6)
60+	4 (9.5)	5 (50)	9 (17.3)
Sex — no. (%)			
Female sex	26 (61.9)	8 (80)	34 (65.4)
Male sex	16 (38.1)	2 (20)	18 (34.6)
Race or ethnic group — no. (%)			
Asian	8 (19)	0	8 (15.4)
Black	11 (26.2)	0	11 (21.1)
White	20 (47.6)	10 (100)	30 (57.7)
2+ races, Other	3 (7.1)	0	3 (5.8)
Hispanic or Latino (of any race)	3 (7.1)	0	3 (5.8)
BMI class — no. (%)			
<18.5	2 (4.8)	0	2 (3.8)
18.5-24.9	17 (40.5)	4 (40)	21 (40.4)
25-29.9	15 (35.7)	3 (30)	18 (34.6)
30-34.9	5 (11.9)	3 (30)	8 (15.4)
>35	3 (7.1)	0	3 (5.8)

Conclusions & Future Directions

- Collected data demonstrate stability of spatiotemporal parameters and plantar pressure measurements.
- We detected significant differences in spatiotemporal parameters of gait between HV and MN, and asymmetry of pressure loading between affected and non-affected feet in MN.
- Results of metatarsal pressure measurements in MN may reflect individual differences in compensatory gait changes developed from chronic pain.
- Future analyses will correlate PROs of pain and functional limitation with observed gait measurements for both feet of individual MN patients.
- Future studies will use gait analysis to supplement functional outcomes in pre- and post-perineural RTX injection in MN patients.