

BACKGROUND & AIM

Functional motor disorders (FMD) are characterized by motor symptoms (e.g., gait disturbance, tremor, dystonia) which resemble voluntary movements (e.g., tremor in one arm might decrease with distraction) but are perceived as involuntary by the patients. The mismatch between the voluntary nature of motor symptoms and the lack of perceived control reported by patients has been linked to abnormal sense of agency. Despite proprioception plays an important role in the sense of agency, impairment of the proprioceptive system in FMD has never been previously investigated. **Aim.** The aim of this study was to explore the role of proprioception in the pathophysiology of the disease by specifically focusing on two main aspects: the sense of position and movement.

METHOD

Participants

Twenty-three patients with FMD (16 women; mean age \pm SD: 43.4 \pm 13.7 years) (Table 1) and 25 healthy controls (HC) (16 women; mean age: 42.4 \pm 17.5 years) were recruited for the study. All participants underwent a passive movement task and a tendon vibration task to assess the sense of position and the sense of movement, respectively.

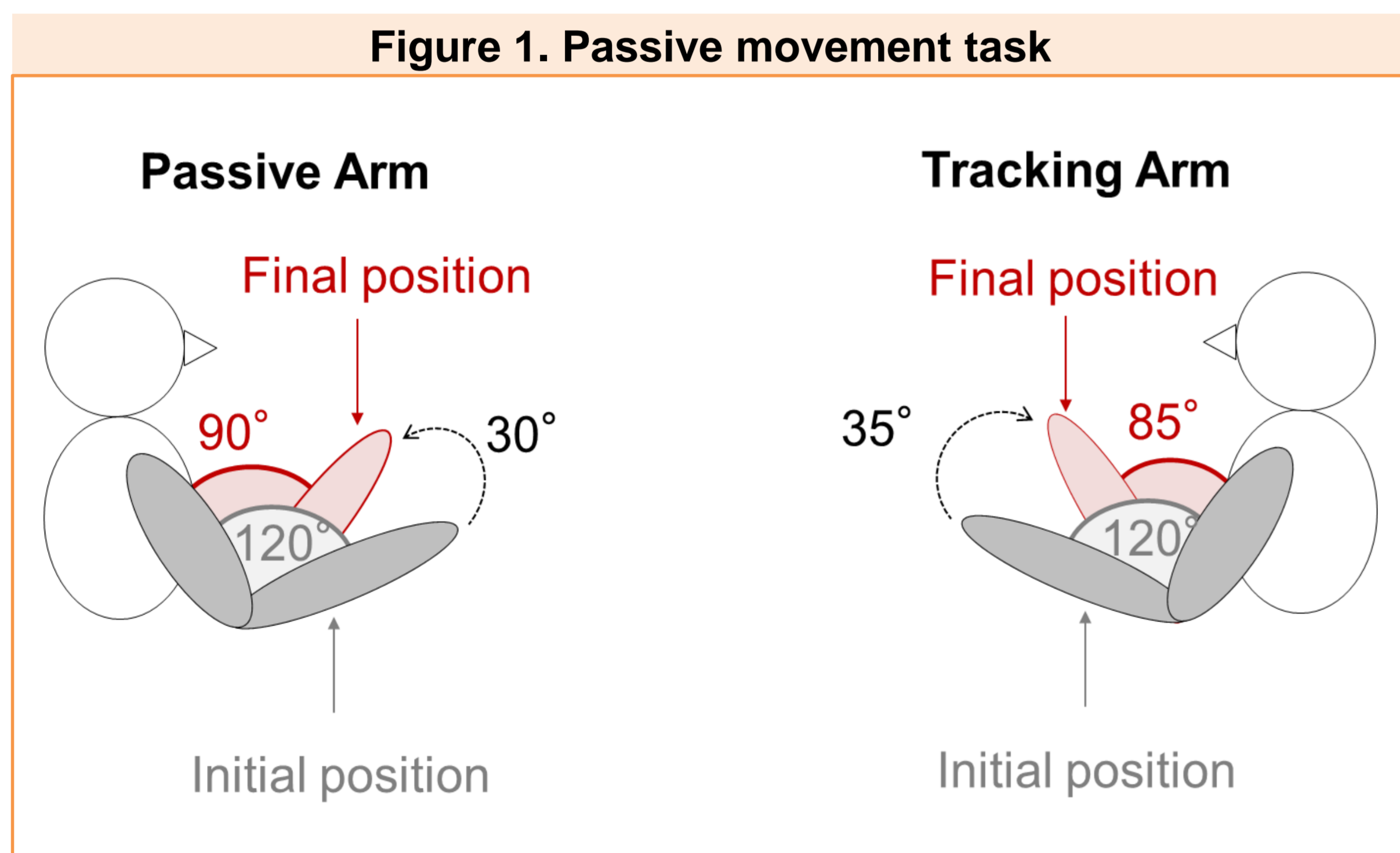
Table 1. Demographic and clinical characteristics of the patients with FMD.

Patient	Age (yrs)	Sex	Handedness	Disease duration (yrs)	Phenomenology (Symptoms localization)
1	61	F	R	2	Weakness (B-LL)
2	39	F	R	2	Tremor and cervical dystonia (R-UL)
3	15	M	R	0,5	Weakness and tremor (B-LL)
4	43	F	R	10	Weakness (B-LL)
5	57	F	R	1	Weakness and tremor (L-UL)
6	69	F	R	7	Weakness (B-LL)
7	25	M	R	4	Weakness and tremor (B-UL)
8	64	F	R	1	Weakness (B-LL)
9	48	M	R	2	Tremor (B-UL)
10	26	F	R	3	Gait disorder (B-LL)
11	40	F	R	4	Weakness (B-UL, B-LL)
12	44	M	R	1	Tremor (B-UL)
13	40	M	R	1	Weakness (R-UL, R-LL)
14	43	F	R	17	Weakness (B-UL)
15	41	F	R	1	Tremor (B-UL)
16	39	F	R	14	Weakness (B-UL, B-LL)
17	39	M	R	2	Weakness (B-LL)
18	51	M	R	2	Weakness and tremor (B-LL)
19	37	F	R	4	Weakness (B-LL)
20	52	M	L	4	Weakness (B-LL)
21	42	F	R	2	Weakness (B-LL)
22	21	F	L	2	Weakness (B-LL)
23	61	F	R	0,5	Dystonia (L-LL)
					Weakness (B-UL, B-LL)

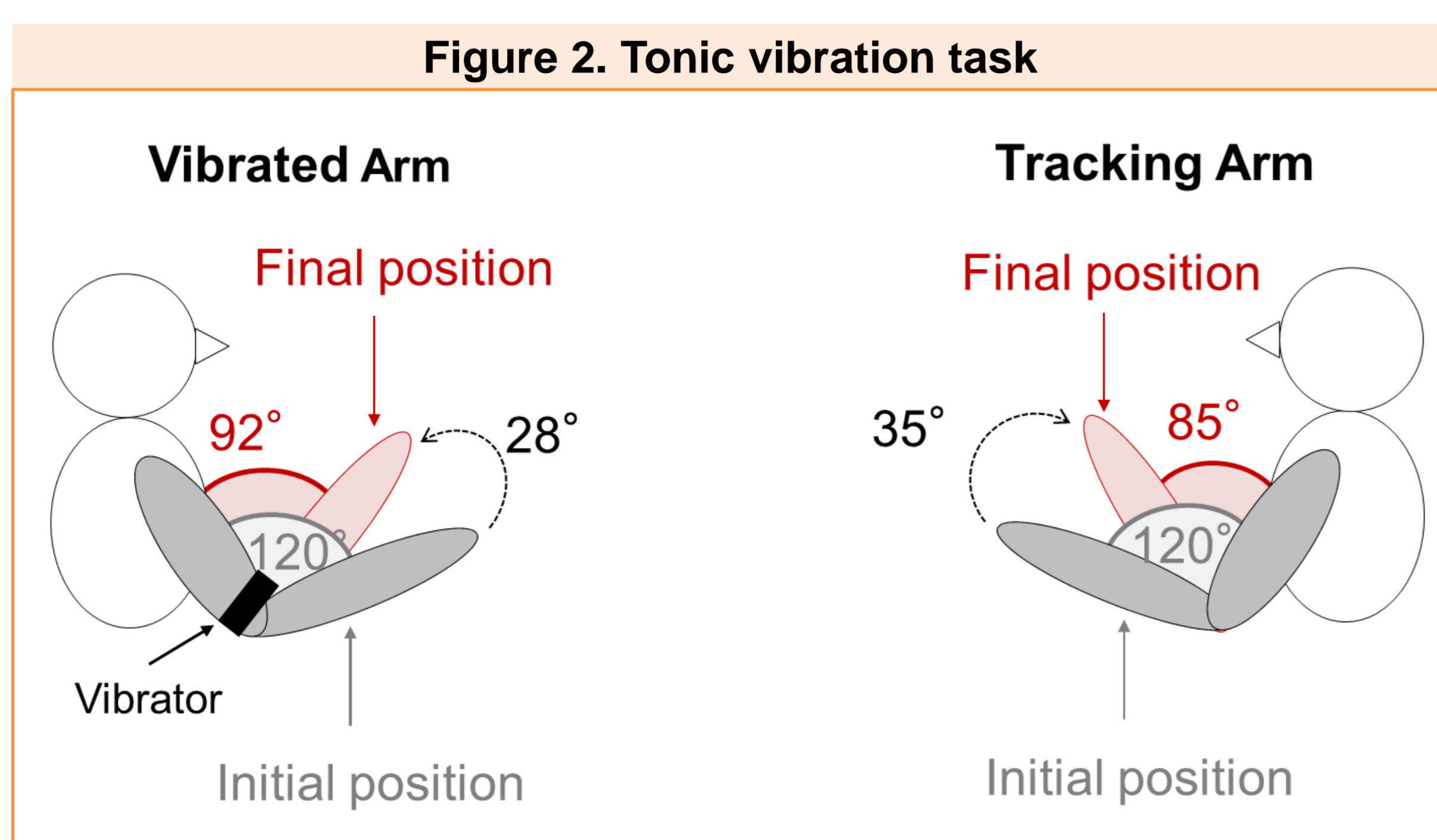
Abbreviations: M: male; F: female; yrs: years; R: right; L: left; B: bilateral; UL: upper limb(s); LL: lower limb(s)

Experimental procedure

In the **passive movement task** (Figure 1), participants were required to match the felt position of a passively moved arm (passive arm) with their contralateral tracking arm. The final angle of the tracking arm was used as measure of sense of position.



In the **tonic vibration task** (Figure 2), a mechanical vibration (92 Hz) was delivered for 45 sec over the bicep brachii tendon of one arm and the participants were again asked to match the movement of the vibrated arm with their contralateral tracking arm. The final angle of the vibrated arm was used as measure of the tonic vibration reflex (TVR) and the final angle of the tracking arm was taken as measure of the sense of movement.



RESULTS

HC were precise in estimating arm position on both task. Conversely, patients were noted to: 1) overestimate the final position of the passively moved arm, indicating altered sense of position (Figure 3a, 3b); 2) underestimate the final position of the vibrated arm, indicating altered sense of movement (Figure 4a, 4b); 3) show a reduced TVR amplitude (Figure 4a), indicating abnormal activation of proprioceptive fibers to vibratory stimulation. These results did not correlate with disease duration and were no different between the affected and the unaffected side.

Passive movement task

Figure 3a. Angular displacement (white bars) and final angle of the tracking arm (colored bars) in FMD (black) and HC (grey) at the passive movement task.

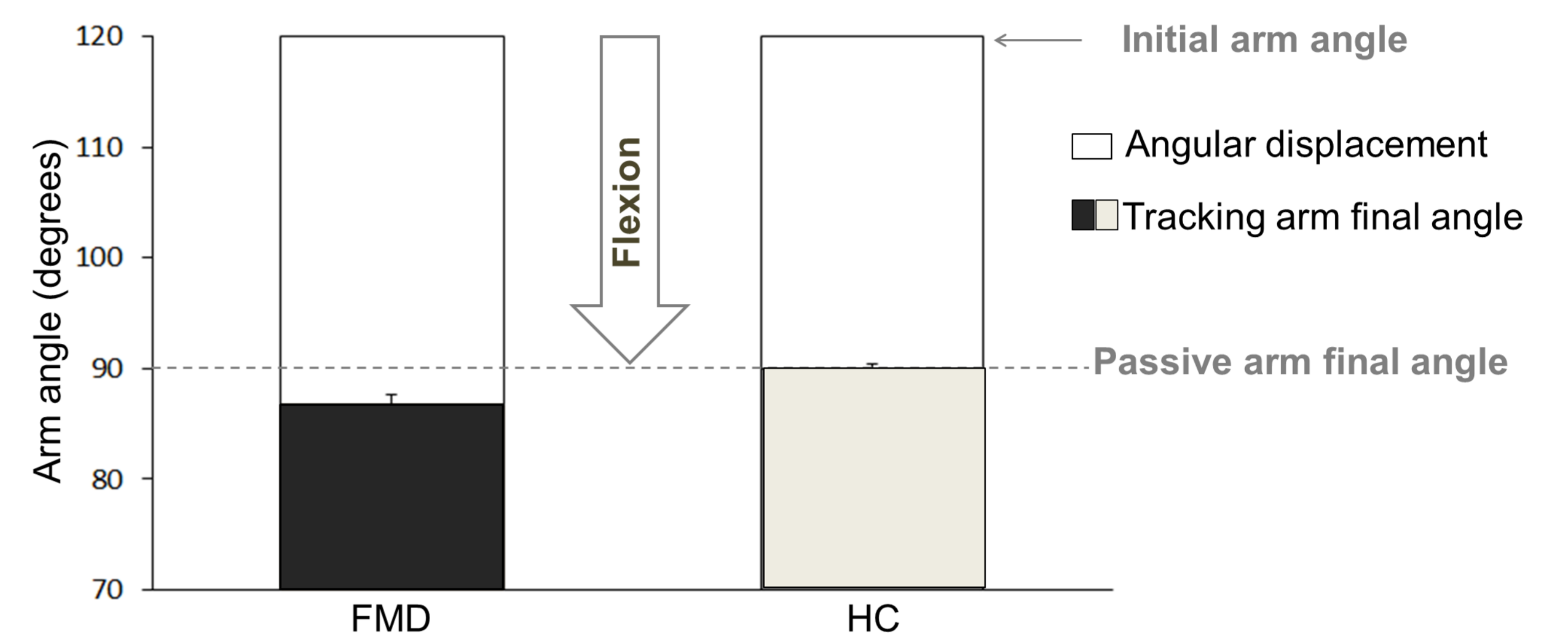
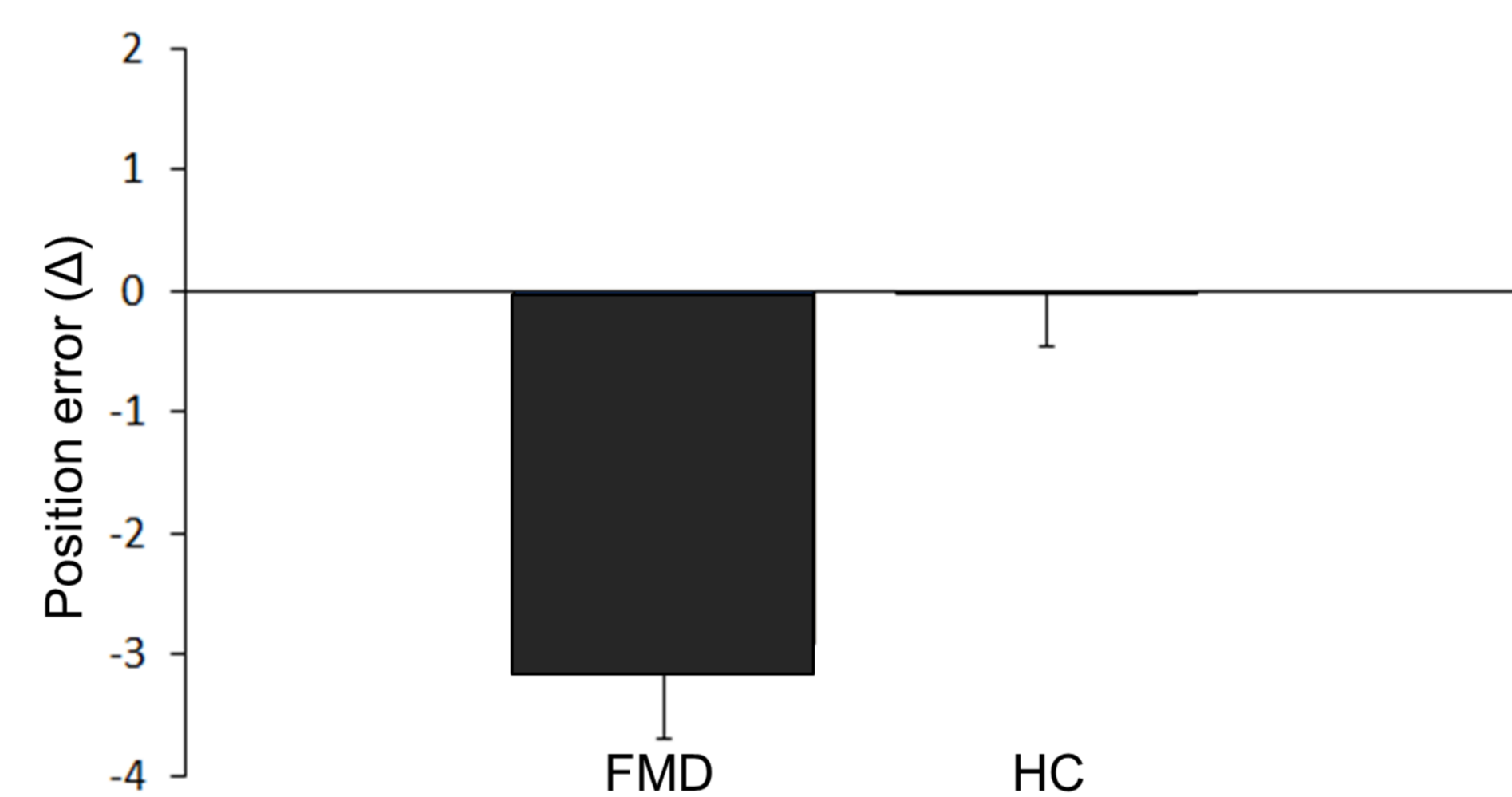


Figure 3b. Proprioceptive error in FMD (black bar) and HC (grey bar) at the passive movement task.



Tonic vibration task

Figure 4a. Angular movement (white bars) and final angle (colored bars) of the vibrated and tracking arm in FMD (black) and HC (grey) at the tonic vibration reflex task.

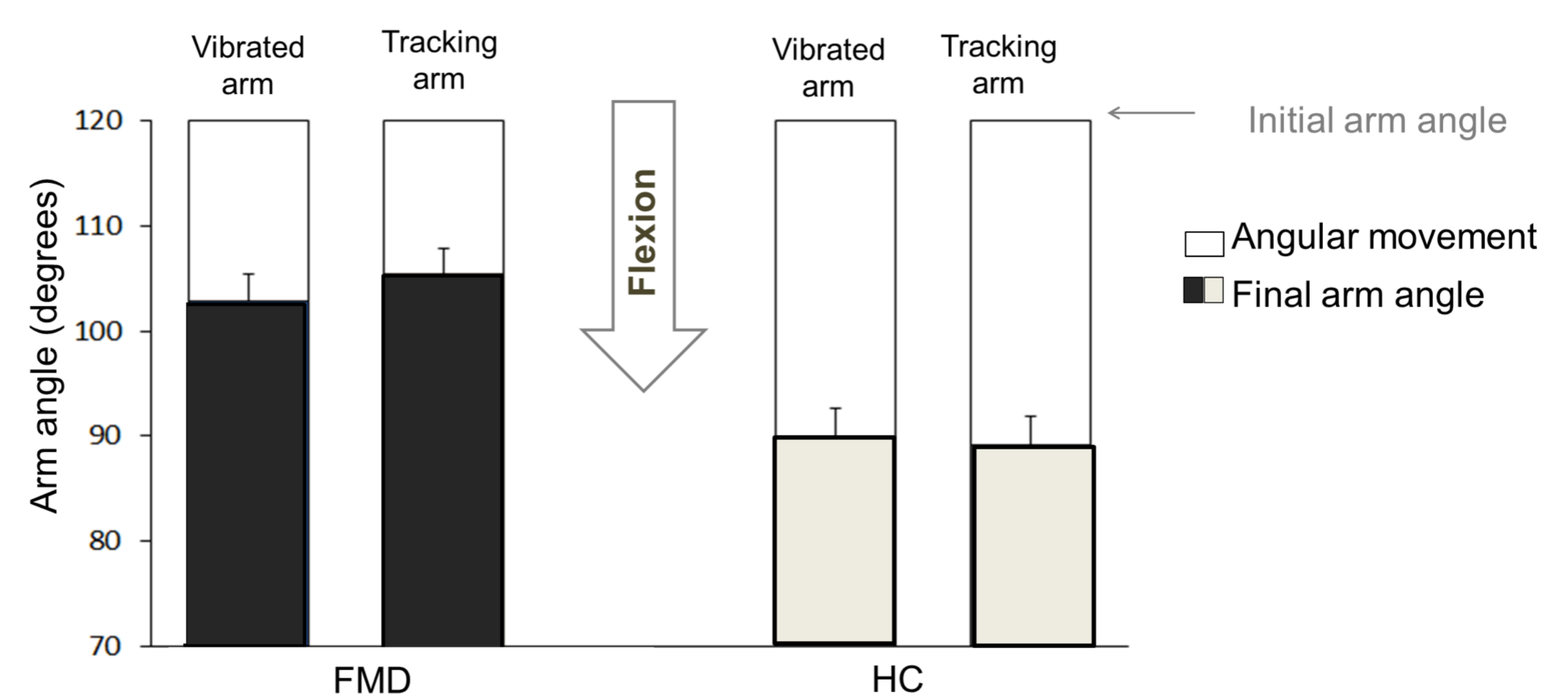
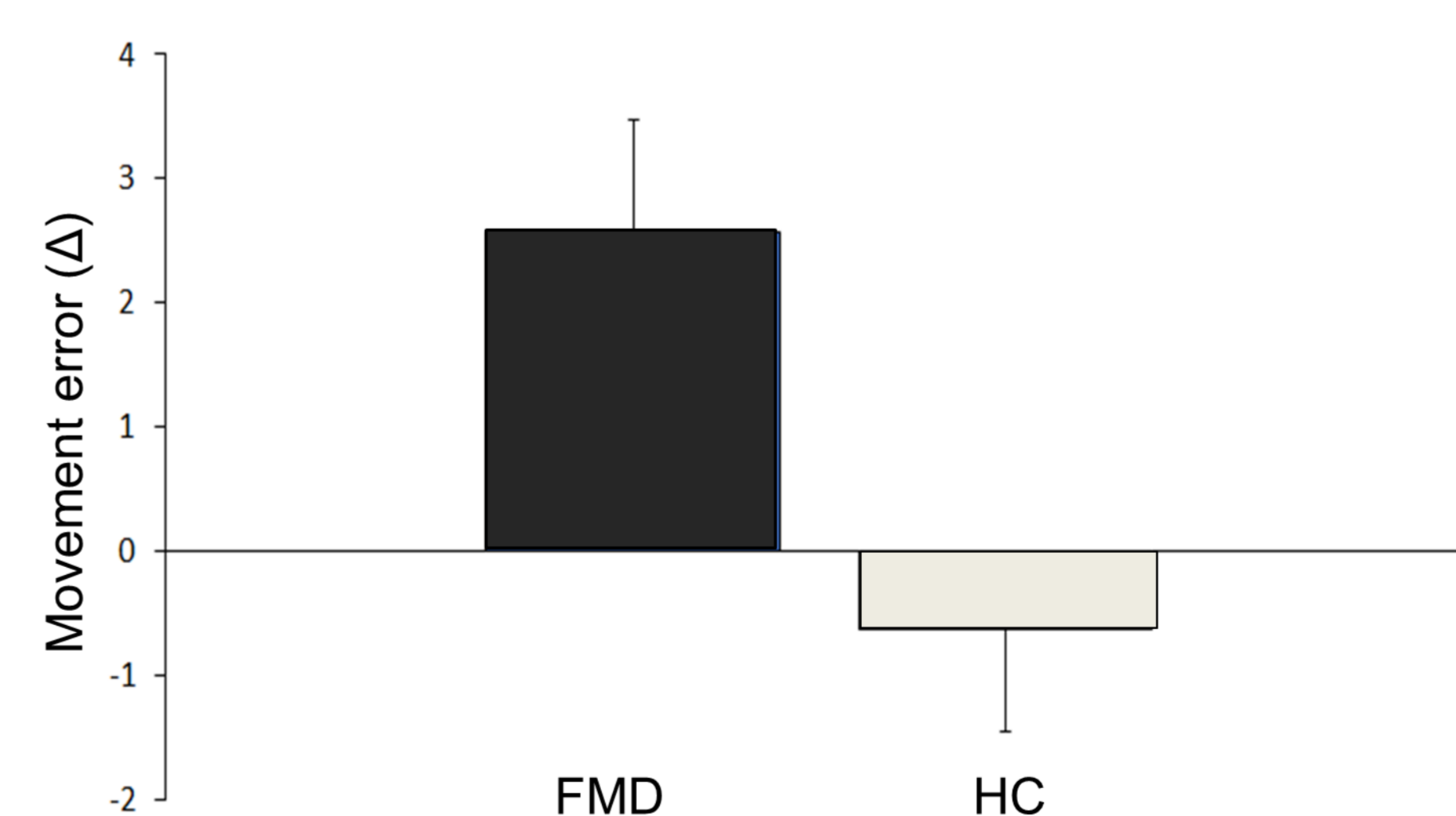


Figure 4b. Proprioceptive error in FMD (black bar) and HC (grey bar) at the tonic vibration task.



DISCUSSION

This study demonstrated for the first time that the sense of limb position and movement are impaired in FMD patients. Such proprioceptive dysfunctions might undermine voluntary movement control and explain, at least in part, abnormal sense of agency in FMD.

REFERENCES

- Edwards MJ, et al (2013) Neurobiology of functional (psychogenic) movement disorders. *Curr Opin Neurol*, 26:442-447.
 Yoneda Y, et al. (2000) Abnormal perception of the tonic vibration reflex in idiopathic focal dystonia. *Eur J Neurol*, 7: 529-33.
 Farrer C, et al. (2003) The role of proprioception in action recognition. *Conscious Cogn*, 12:609-619.

