

Body sway during quiet standing post-stroke: effects of individual and interpersonal light touch

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Abstract (word count: 212)

Lightly touching an external reference, whether a fixed point or another person, reliably improves postural stability. In hemiparetic stroke patients, however, the effect of fixed point light touch (LT) on balance is uncertain. Moreover, it is not clear whether stroke patients respond in the same manner as healthy controls to light interpersonal touch (IPT). In the present study, therefore, the effects of LT and IPT on balance were contrasted in older adults with and without chronic hemiparetic stroke. Participants stood with open eyes in comfortable, normal bipedal quiet stance and performed 4 contact conditions in random order: no contact, fingertip LT, active fingertip IPT and passive elbow IPT. Body sway varied in response to the contact condition in both groups. The hemiparetic patients, whose impairment was relatively mild, showed responsiveness to LT and IPT similar to the non-hemiparetic group in terms of proportional sway reduction in the anteroposterior but not in the mediolateral sway direction. This indicates that light touch effects are robust but cannot be generalized from healthy older adults to hemiparetic stroke patients without consideration of moderating functional constraints of the individual and the specific postural context. Future research should include hemiparetic individuals with moderate to severe postural deficits to determine possible limitations of light touch balance support in stroke.

Keywords: hemiparetic stroke, light touch, interpersonal touch, body balance

Conflicts of interest

The authors declare that they have no conflict of interest.

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(word count: 782)

Dear Ladies and Gentlemen,

Individuals with hemiparetic stroke have an elevated falls risk [1,2]. In clinical practice, therefore, evidence-based strategies for the augmentation of sensorimotor control of posture are required that facilitate patients' performance without the provision of too much mechanical body weight support. Lightly touching an earth-fixed external reference point generally improves stability of posture [3]. In stroke patients, however, the effect of light touch (LT) on balance have been demonstrated [4] but are less certain. For example, Boonsinsukh et al. [5] showed that LT provided by a cane stabilizes mediolateral trunk sway during walking, while Ijmker et al. [6] could not find any evidence for optimized walking with LT of a handrail. It seems, therefore, that the utilization of LT is not as straight forward in stroke as it might be in other balance-impaired populations.

Another strategy observed in daily life is light touch provided by a caregiver. In older adults, light collaborative ("active") fingertip-to-fingertip interpersonal touch (IPT) results in sway reductions in quiet standing [7]. Deliberately light IPT received to the back ("passive") also reduces sway in stroke patients [8]. In the present study, the effects of LT as well IPT were contrasted between older adults with and without chronic hemiparetic stroke.

Seven chronic hemiparetic stroke patients (6 female, 1 male; age: 61-69 yrs; time since lesion: >1 yr; 5 ischemic, 2 hemorrhagic; lesioned hemisphere: 4 left, 3 right; paresis range: 3-5 (arm), 2.5-4 (leg); Berg-Balance-Scale: 44-51; Rivermead Mobility Index: 7-11; Modified Rankin Scale: 2-3) and 11 healthy older adults (4 female, 7 male; age range: 63-77 yrs; Berg-Balance-Scale: 50-56) were recruited from the community. All participants were right-handed and able to stand unsupported. Individuals with other neurological pathology, orthopaedic or rheumatic conditions or who were unable to follow verbal instructions were not included.

Participants stood with open eyes in comfortable, normal bipedal quiet stance on a force plate (Bertec 4060FP; 200 Hz; normal footwear) and performed 4 blocks of 10 stance trials (duration: 20 s) in random order: no contact (NC), fingertip LT (fLT), active fingertip IPT (aIPT) and passive elbow IPT (pIPT). During all trials, one contact provider stood perpendicular to the participant on the side of the dominant arm (unaffected arm in stroke) to ensure participants' safety and to apply continuous IPT when instructed. Participants held their arm in a default elbow-flexed posture enabling the tip of the extended index finger to contact a height-adjustable stand positioned in front. Sway data were low-pass filtered (4th order dual-pass Butterworth with 10Hz cut-off) and differentiated to express body sway in the anteroposterior (AP) and mediolateral (ML) directions as the standard deviation of Centre-of-Pressure rate of change. Mixed multifactorial ANOVAs with contact conditions as within-subject factor and group as between-subject factor were calculated. An alpha level of $p < 0.05$ was used after Greenhouse-Geisser correction.

Body sway varied in response to the contact condition in both groups (Fig. 1). In the healthy controls, sway was reduced compared to the control condition in both directions of sway (both $p \leq 0.02$; fLT: AP -35%, ML -22%; aIPT: AP -11%, ML -11%; pIPT: AP -6%, ML -12%). This occurred for the stroke patients in the AP direction only ($p = 0.02$; fLT: AP -32%; aIPT: AP -8%; pIPT: AP -15%).

--- insert Figure 1 about here ---

Our results showed that in the AP direction mildly impaired, chronic hemiparetic stroke patients possess similar responsiveness to LT and IPT in terms of proportional sway reductions comparable to the control participants and previous reports in older adults [7]. Although quite capable, our sample of stroke patients still showed relative instability despite the availability of touch in the ML direction, which indicates a limitation. Interestingly, we found no difference between the two IPT conditions in both groups, which contrasts with recent findings for balance exercises in older adults, where collaborative IPT was more effective [9]. Paresis of the proximal segments of leg and the hip could have interfered with improved postural stability in the frontal plane [10,11] in some of our stroke participants. In general, our study indicates that the effects of light touch are robust but cannot be generalized from healthy older adults to hemiparetic stroke patients without consideration of moderating functional constraints of the individual and the specific postural context, such as postural degrees-of-freedom and positioning of the contact relative to the individual [12]. Despite the positive responsiveness to light haptic augmentation in our stroke patients, it is known that some severely impaired stroke patients, e.g. showing contraversive pushing behaviour, do not utilize haptic feedback and resist passive interpersonal support [13]. Nevertheless, patients and clinicians alike should be encouraged to apply light touch balance support strategies where safely possible for the augmentation of mechanically unsupported postural control.

Ethical standards

The study accorded to the ethical principles laid down in the 1964 Declaration of Helsinki and its later amendments and was approved by the University of Birmingham Research Ethics Committee. All participants gave their informed consent prior to their inclusion in the study.

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Figure caption

Figure 1.

- (A) Interpersonal stance configuration for the light collaborative, “active” fingertip-to-fingertip interpersonal touch (aIPT; upper panel) and the “passive” elbow interpersonal touch (pIPT; lower panel) conditions.

(B) Bar plots of the variability of Centre-of-Pressure rate of change (SD dCoP) for both groups of participants in both directions as a function of the light touch contact condition. Horizontal arcs indicate significant post-hoc single comparisons ($p < 0.05$). NC: no contact; fLT: fingertip light touch to stand reference; error bars show the standard error of the mean across participants.

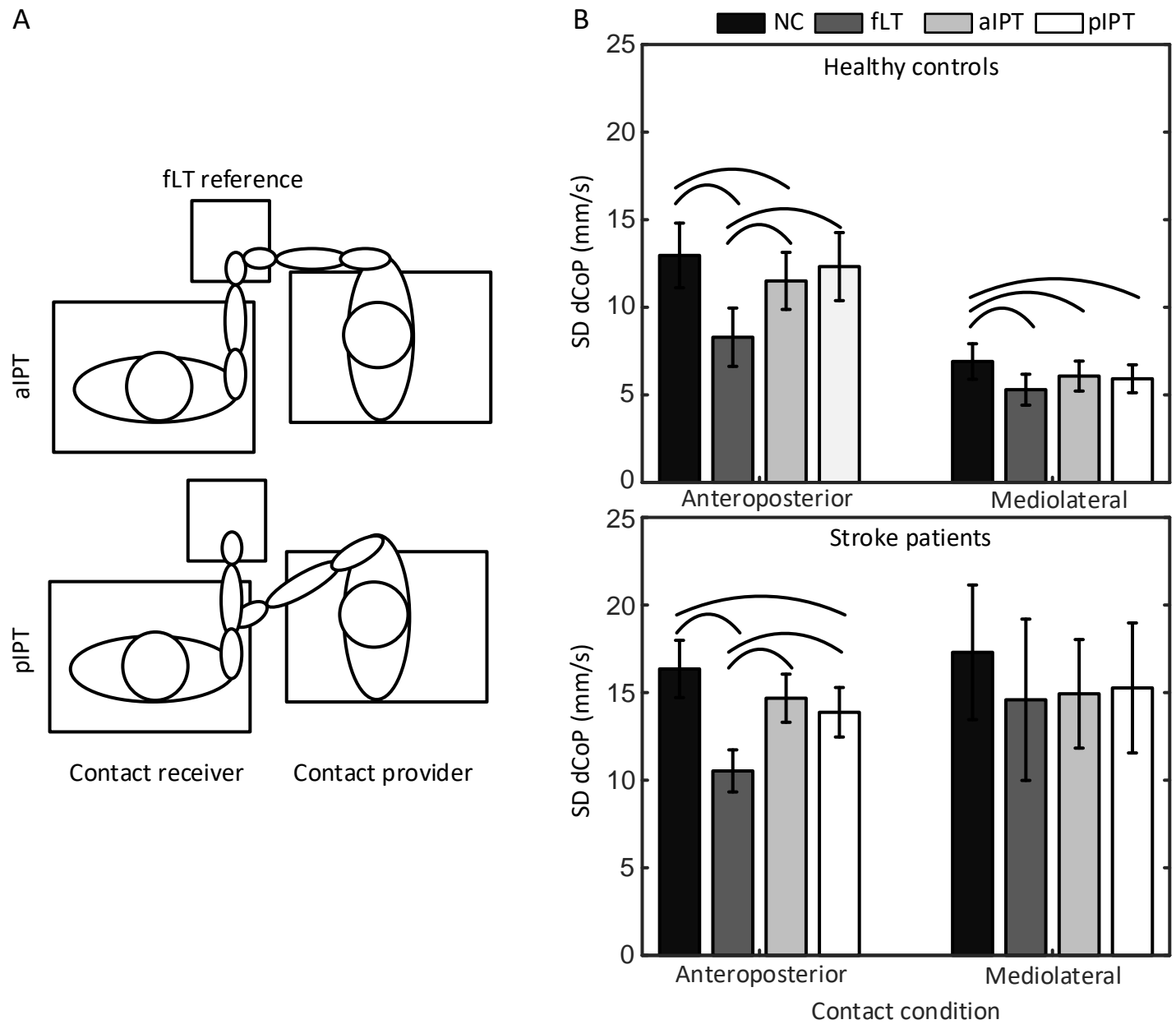


Figure 1.