UNIVERSITY OF BIRMINGHAM | CENTRE OF PRECISION REHABILITATION FOR SPINAL PAIN

BTS Bioengineering

IMPAIRED SHOCK ATTENUATION IN PEOPLE WITH CHRONIC NECK PAIN DURING CURVILINEAR GAIT

D. Jiménez-Grande, A. Alsubaie, A.M. De Nunzio

Centre of Precision Rehabilitation for Spinal Pain (CPR Spine), School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham, UK

Introduction

Humans deal frequently with changes in path direction, yet few studies evaluate gait along curved trajectories and given the importance of neck sensorimotor control during walking and turning[1], it is clinically relevant to consider the impact of the neck pain which can impair the muscular ability to absorbing the ground reaction forces propagating from the legs to the head during gait[2] and can altered the co-activation to avoid the pain[3].

Aim

This study examined the shock attenuation function at neck, trunk and leg level and the time-varying multi-muscle co-activation function on different muscles at neck and back level during walking along rectilinear and curvilinear trajectories in people with chronic neck pain (CNP) versus asymptomatic control (AC).

Methods

Twenty-six AC (age: 26 ± 10.6 years) and twenty-one subjects with CNP (age: 28.5 ± 12.4 years, average pain intensity: 4.5 ± 1.9/10) performed three gait repetitions at natural speed, along a rectilinear path (10m) and a curvilinear path clockwise and counter clockwise (1m radius) and simultaneously, a motion analysis system was used for the acquisition of kinematics and muscle activity.

During the gait subjects wore six passive reflective positioned above the anatomical reference points and a system of acquisition sEMG (FreeEMG, BTS SpA, Milan, Italy) with probes placed on splenius capitis sternocleidomastoid and erector spinae right and left side muscles.

From the processed EMG signals, we calculate the simultaneous activation of the muscles using the time-varying multi-muscle co-activation function (TMCf) proposed by Ranavolo[4]. Mean shock attenuation index (MSA) at neck, trunk and leg was calculated from the power spectral density of the respective segments during the right gait cycle[5].

Results

The mean MSA at the neck level was significantly higher (less shock absorption) in CNP compared to AC during external direction (*P = 0.020*, see Figure 1) and the TMCf in the sternocleidomastoid was significantly higher in CNP during the same direction (*P = 0.021*, see Figure 2) as well, while no significant differences were found for the other gait directions for MSA indexes or TMCf mean.

Conclusion

The reduced shock absorption at the neck level in people with CNP can be due to impaired control of the neck muscles. The higher speed of the outer (external to the curvilinear direction) part of the body motivates the higher MSA neck for CNP during the counter clockwise condition (outer right gait cycle). Challenging the motor control, with curvilinear gait, highlights impairments in the shock absorbing function and in the co-activation of the neck in people with CNP.

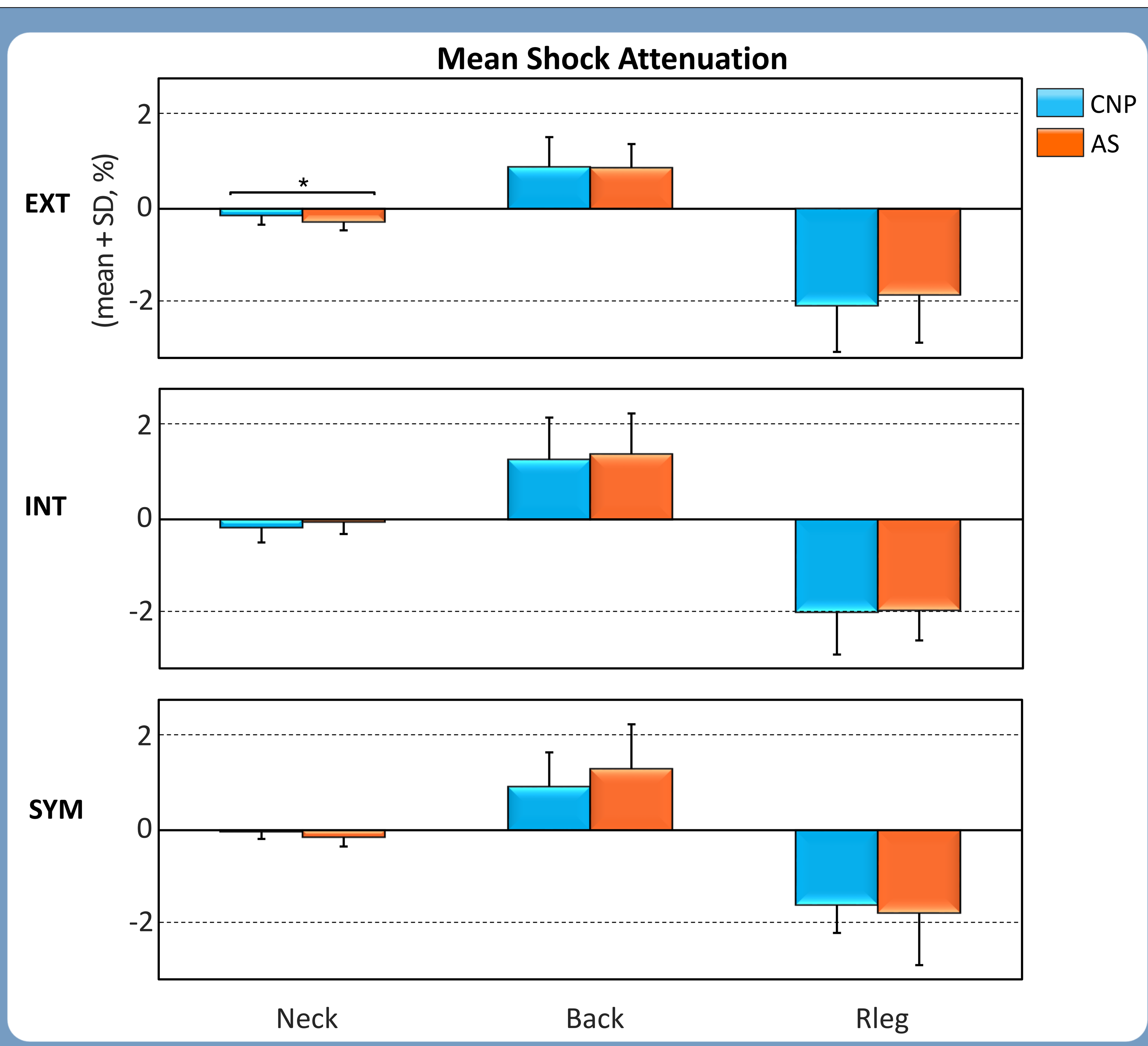

Figure 1. Mean + SD of the Shock attenuation at External (EXT = counter clockwise), Internal (INT = clockwise) and Symmetric (SYM = rectilinear) directions between CNP and AS groups.

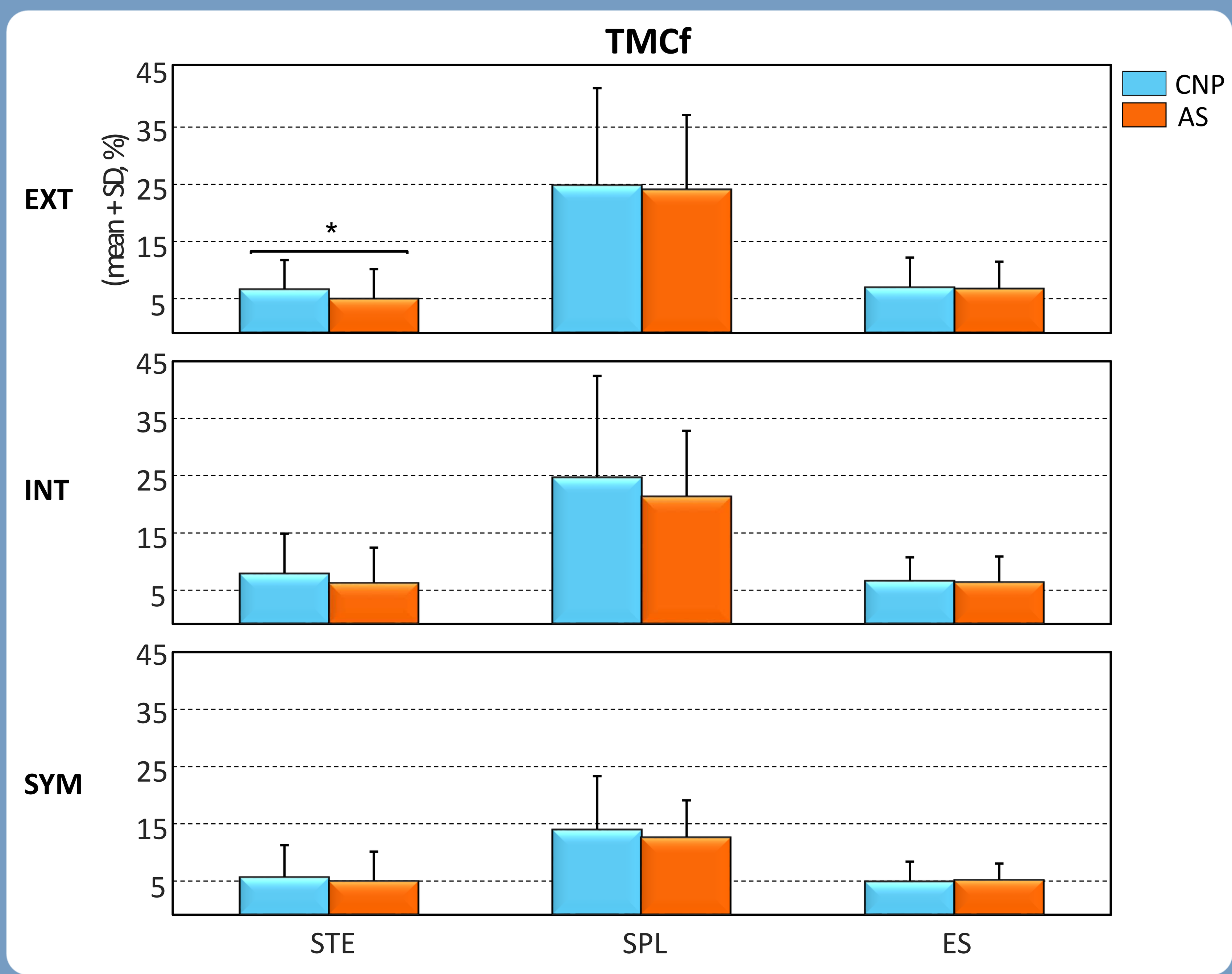

Figure 2. Mean + SD of the Time-varying multi-muscle co-activation function (TMCf) on Sternocleidomastoid (STE), Splenius (SPL) and Erector Spinae (ES) during External (EXT = counterclockwise), Internal (INT = clockwise) and Symmetric (SYM = rectilinear) directions between CNP and AS groups.

References

1. Imai, T. et al (2001). "Interaction of the body, head, and eyes during walking and turning." Exp Brain Res.
2. Voloshin, A. et al (1981). "Influence of artificial shock absorbers on human gait". Clin Orthop Relat Res.
3. Falla, D. et al (2004). "Spatio-temporal evaluation of neck muscle activation during postural perturbations in healthy subjects ". J Electromyogr Kinesiol.
4. Ranavolo, A. et al (2015). "A new muscle co-activation index for biomechanical load evaluation in work activities." Ergonomics.
5. Castillo, E. R. et al (2018). "Shock attenuation in the human lumbar spine during walking and running."J Exp Biol.