IN VIVO NECK STIFFNESS REPRODUCIBILITY IN RESPONSE TO QUICK RELEASES

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INTRODUCTION

Many studies have shown that mechanical perturbations applied to the head are responsible for cervical injuries [1,2]. It has been suggested that increase in several factors of the head-neck segment stiffness such as neck elastic series component (SEC) stiffness, strength, and girth could improve stability of the head [3]. Decreasing cervical spine deformation during load application could thus prevent neck related injuries. To our knowledge, there is no study about evaluation of SEC mechanical properties of the neck. Quick releases (QR) application seems to be an adequate method for measuring neck SEC stiffness because it has already been validated for other corporal segments [4]. The aim of this study was to investigate the reproducibility of neck stiffness measures through application of QR.

METHODS

13 healthy subjects (27 ± 3 years) performed neck maximal isometric voluntary contractions (MVC) in flexion (F) and extension (E). In similar experimental conditions, the QR trial was performed in F and E at two different times (T1 and T2) separated by 7 days. Each trial included 16 QR tests performed at submaximal isometric strength. Using an accelerometer located on the head, head kinematics was assessed from the first acceleration peak (a_{peak}) following the release (Figure 1, top). Angular stiffness (S) was estimated as the slope of the linear regression between angular displacement (θ) and strength level (C) (Figure 1, bottom). θ was calculated by a two-time integration of angular acceleration (θ”). θ” was calculated as the ratio between tangential acceleration and the distance between C7 vertebrae and the accelerometer.

RESULTS AND DISCUSSION

No significant differences were found between T1 and T2 for MVC in F and E. No significant differences were found between T1 and T2 neither for S during the first 15 ms in F and E, nor for the ratio between C and a_{peak} in F. For other phases (p_1 or until θ” = 0 and p_2 or until speed (θ’) = 0), S was not reproducible (Table 1).

MVC in E and F was highly reproducible and S was also reproducible for the first 15 ms but not for the other phases. In experiments using QR devices, kinematic data are usually recorded during the first 15-20 ms from the a_{peak} when the elastic elements are supposed to recoil and before any reflex changes in muscle activation were possible [4]. Furthermore, cervical spine is a multi-linked segment. Head-neck dynamic response to QR application could not be only angular in phases longer than 15 ms but rather an association of angular and linear kinematic components. These geometrical variations could be the result of displacement of centre of rotation of the head-neck segment during the movement or related to C.

CONCLUSION

Reproducibility of the slope of the linear regression between θ and C in the first 15 ms after a_{peak} shows that neck S could be measured with QR applications.

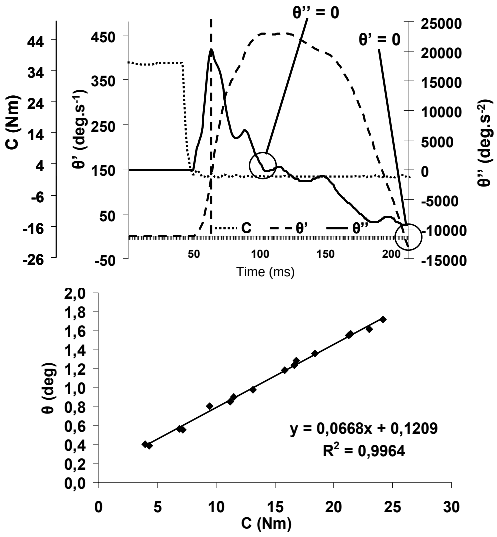

Figure 1: Top, typical θ” and θ’ during extension trial. The vertical dotted line represents the a_{peak}. Bottom, typical θ/C linear regression in one subject for extension (Δt = 15 ms).

REFERENCES

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Table 1: Mean and reproducibility of kinematic data and MVC between test (T1) and retest (T2). N = 13.

	Mean T1	SD T1	Mean T2	SD T2	SEM	SEM (%)	ICC	ICC-95	ICC+95
MVC F (Nm)	38	12	40	13	3,6	9	0,92	0,74	0,97
MVC E (Nm)	58	19	60	18	3	5	0,97	0,91	0,99
a_{peak}/C F ($rad.s^{-2}.Nm^{-1}$)	604	158	580	162	92	31	0,66	0,18	0,89
a_{peak}/C E ($rad.s^{-2}.Nm^{-1}$)	567	161	572	151	111	31	0,55	0	0,85
S F (°/Nm)	0,06	0,02	0,06	0,01	0,01	15	0,64	0,13	0,88
S E (°/Nm)	0,05	0,01	0,05	0,01	0,0001	10	0,83	0,51	0,95
Sp_1 F (°/Nm)	0,44	0,15	0,40	0,15	0,1	23	0,6	0,07	0,86
Sp_1 E (°/Nm)	0,45	0,17	0,32	0,32	0,18	46	0,51	-0,06	0,83
Sp_2 F (°/Nm)	0,13	0,67	0,16	0,64	0,18	30	0,54	-0,02	0,84
Sp_2 E (°/Nm)	-0,18	0,96	0,04	0,84	0,27	36	0,56	0,02	0,85