# Development of Test Methods for Neck Braces Effectiveness Evaluation in the Preliminary Definition of a Standard Procedure

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**INTRODUCTION**. Neck injuries represent a critical issue for people's safety and protective gear must be used during high-risk activities to reduce the severity of traumas. Tolerance limits for flexion, extension, lateral bending and torsion range of motion and force/moments were evidenced in previous studies [1]. Nevertheless, neck braces are not yet tested accordingly and are only subjected to basic comfort and robustness assessments. The aim of the present work is to present a test method for assessing the effect of neck braces on neck kinematics suitable as initial proposal of a standard test method

**METHODS.** A Hybrid III (JASTI, Japan) dummy seated in an impact pendulum was fixed at the trunk/shoulder with slings. On the dummy chest we placed a commercial neck-brace and on dummy's head we fitted a compatible motorcycle helmet. The dummy was hit in a forehead/side/backhead position with a steel pendulum at potential energy of 100 J, 4,5 m/s(similar to EN 1077) (Figure 1.a). Reflective markers were placed on chest and head visible portion, as well as on neck-brace and helmet. 3D Kinematic data were captured using a Bonita camera system (Vicon, U.S.A.) at 200 Hz. Data were processed to measure trunk, head and helmet absolute angles and calculate neck flexion/extension angles in the sagittal/frontal plane, as well as helmet/head relative movements.

**RESULTS.** Preliminary results in a forehead impact are presented. Neck relative extension angle is shown in Fig 1b with and without neck brace. The neck relative angle reached in both cases peak values of 70° with respect to the neutral position, captured with sufficient resolution at 200 Hz. Maximum head-helmet relative angle reached 6° (no neck brace) and 22° (with neck brace).

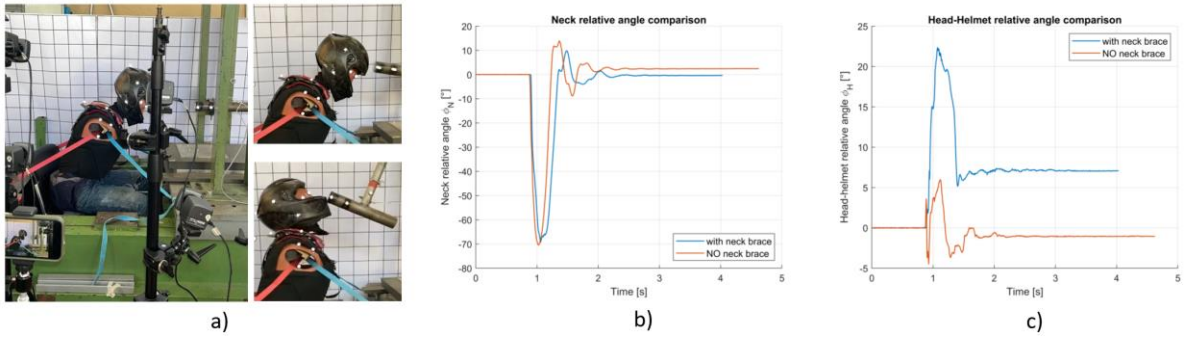


***Figure 1*** *a) experimental setup; b) neck relative angle; c) head-helmet relative angle*

**DISCUSSION AND CONCLUSIONS.** Preliminary experiments confirm that the method allows inducing a neck hyperextension/flexion/lateral bending and assessing the effectiveness of neck-braces: current head impact methods do not include the neck or just focus on energy absorption. To avoid errors in the neck angle evaluation, suitable methods are needed to obtain the head rather than helmet angle, as the differed significantly. Helmets play a crucial role in this setup, as different helmet properties and geometries affect the interaction with the neck brace. Tests can be repeated with various neck braces to reach safe or unsafe range of motion [2]. Other alternative test setups are under investigation to cover other possible mechanisms which could lead to potential neck injuries.

**REFERENCES.**

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