Does a Chin Bar-Mounted Action Camera Increase Head Injury Risk in Facial Impacts?

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I. INTRODUCTION

Helmet-mounted action cameras and accessories are now widely used in motorcycling, often attached to the chin bar of full-face helmets to record point-of-view footage. However, it remains unknown whether chin bar mounting alters head impact biomechanics and increases the risk of head injury during motorcycle crashes. Previous studies have evaluated helmet attachments under front, crown, lateral, and rear impact configurations [1–3], but have not specifically examined the chin bar-mounted conditions in facial impacts, despite evidence that such impacts account for nearly 50% of head impacts in motorcycle crashes [4]. This study applies a recently developed facial impact test method [5] based on real-world motorcycle crash reconstructions [6] to determine whether a chin bar-mounted action camera alters head impact biomechanics and head injury risk in facial impacts. The hypothesis is that a chin-bar mounted action camera, or any external protrusion, exacerbates injury risk.

II. METHODS

An oblique chin-bar impact test was performed. Representative head impact conditions based on 30 reconstructed real-world motorcycle collisions and sensitivity analysis [5] were translated to a drop-test method with the following parameters: impact velocity of 8.5 m/s, anvil angle of 45°, and headform orientation of 90° in the sagittal plane. The new EN 17950 Headform (Size 570), which better represents human head shape, inertial properties, and the coefficient of friction than other headforms [7], was used. Six ECE 22.06-certified helmets were tested: three with a chin-bar mounted action camera and three without, providing three repeated tests for each condition. The camera assembly consisted of a 3D-printed surrogate matched to the mass and geometry of a popular action camera model (GoPro Hero 10), a camera casing, and chin mounts attached to the helmet chin bar using 3M™ VHB™ adhesive tape (Fig. 1). Peak resultant linear acceleration, peak angular acceleration, and Brain Injury Criteria (BrIC) were calculated as head injury metrics. A two-sample t-test was used to determine whether differences between helmets tested with and without the camera were significant ($p < 0.01$).

Fig. 1. The helmet with a chin bar-mounted action camera.

III. INITIAL FINDINGS

Compared with the no-camera condition, the chin bar-mounted camera reduced peak linear acceleration by 32% ($p < 0.001$), peak angular acceleration by 55% ($p < 0.01$), and BrIC by 59% ($p < 0.001$) (Fig. 2a). High-speed video indicated greater sliding and less head-helmet rotation during impact in the camera condition (Fig. 2b), which is consistent with the reduced rotational injury metrics. In all camera tests, the chin vent cover fractured and the adhesive mount detached. Between-test variability was low, with coefficient of variation for all injury metrics below 3% in the no-camera condition and below 9% in the camera condition, despite one camera test showing markedly lower angular acceleration.

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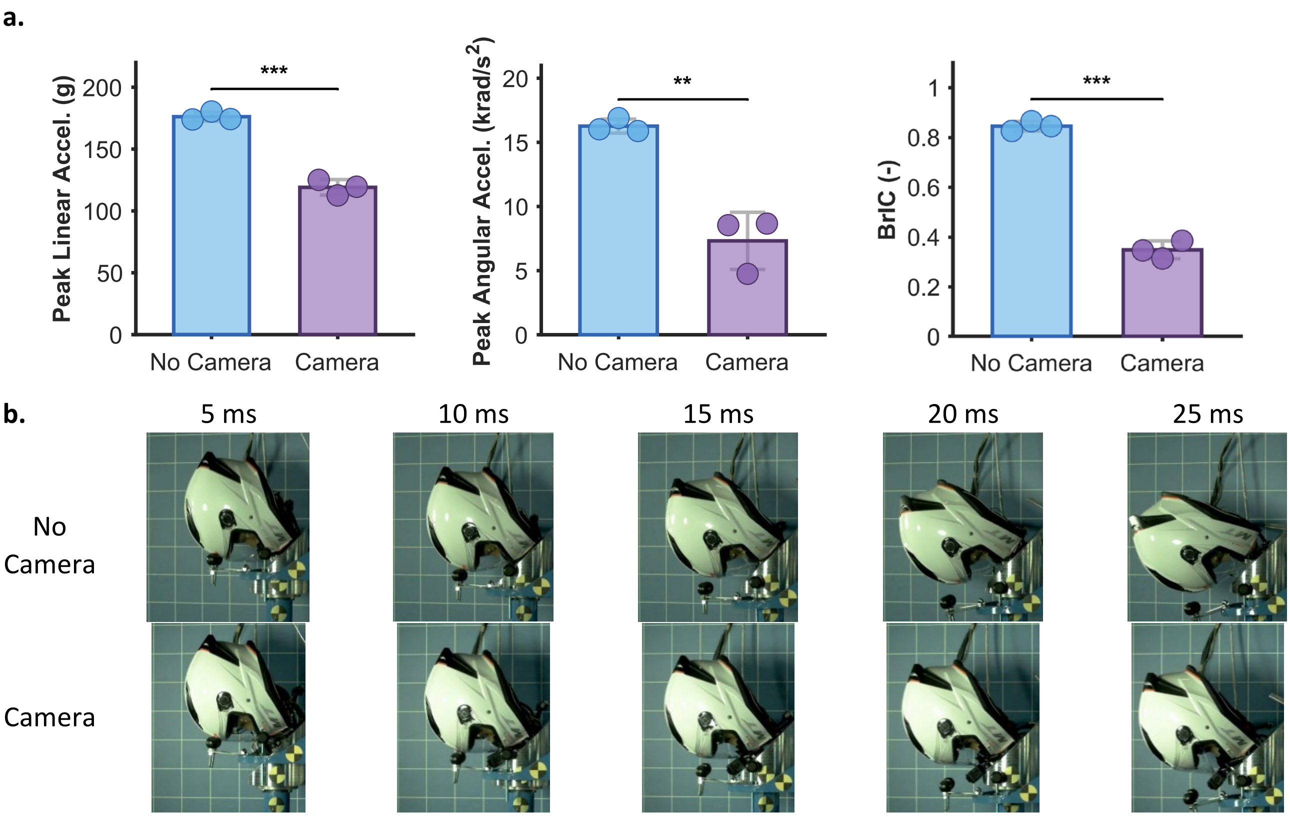

Fig. 2. Comparison between the helmet without a camera and with a chin bar-mounted action camera for (a) peak head kinematics (two-sample t-test, ** $p < 0.01$, *** $p < 0.001$) and (b) snapshoots from high-speed video showing less head-helmet rotation and more sliding in the camera condition.

IV. DISCUSSION

Contrary to the hypothesis that external protrusions exacerbate injury risk, our data showed that a chin bar-mounted action camera consistently reduced all head injury metrics. The reduced rotational response may be explained by a mechanical decoupling mechanism: the fracture of the chin vent cover and detachment of the adhesive mount effectively altered the helmet–anvil interaction during impact and attenuated the energy which would otherwise transfer to the head-helmet. This is aligned with findings from prior studies showing that attachments do not necessarily increase risk [1–3] and the failure mode of the helmet or accessory may be an important determinant of head injury metrics.

The present findings should not be generalised for all chin bar-mounted action cameras and accessories, as only one helmet model and one chin mount type were tested. Nevertheless, the mechanism described here may help inform safer helmet and accessory design. Furthermore, the high repeatability of these results (low between-test variability) also supports the feasibility of incorporating the oblique chin-bar impact test into future helmet rating and regulatory frameworks. Such testing is important to ensure helmet-mounted cameras and accessories do not compromise, but perhaps even enhance, helmet protective performance.

V. REFERENCES

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