CLINICAL AND BIOMECHANICAL RESEARCH FOR BICYCLE HELMET OPTIMISATION

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Abstract. Epidemiological studies on bicycle accidents show that a substantial fraction of the cyclists that call for medical aid, are suffering from skull and brain damage. The aim of the research performed at the K.U.Leuven is to reduce the risk of serious head injuries by the creation of a new type of bicycle helmet. To achieve this goal, a clinical review of pedal cyclist head lesions has been performed, a 3D accident simulation program has been developed, skull behaviour during impact testing has been studied and the current protective effect of a typical series of bicycle helmet has been evaluated. The absence of a temple cover allows a potentially dangerous contact between the temple of the head and the impact surface [1].

Key words: bicycle helmet, impact modelling, skull fracture.

1. INTRODUCTION

Pedal cyclists are a vulnerable group among road users. The most common region injured in bicycle accidents is the head. 21 to 61% of the victims of bicycle accidents who seek medical care have a head injury [2]. Moreover, cranio-cerebral trauma is a direct cause of death for the majority of fatal accidents [3]. To reduce the risk of serious head injuries in bicycle accidents, a clinical review of pedal cyclist head lesions has been performed and a 3D accident simulation program has been developed. Also, skull behaviour during impact testing has been studied and the current protective effect of a typical series of bicycle helmet has been evaluated.

2. MATERIALS AND METHODS

A data bank containing records related to real bicycle accidents was constructed. Each record was associated with one of 86 pedal cyclists that had undergone a neurosurgical intervention at the University Hospital of Leuven in the period between January 1990 and June 2000 as a result of a head injury. The collected data pertained to the accident circumstances, the sustained injuries and the outcome.

In parallel with the statistical analysis of the pedal cycling accidents from a clinical point of view a mathematical accident simulation model was developed with the Dynamic Analysis and Design System™ from LMS. It consists of a 3D multi-body model representing the cyclist and two solitary 3D entities representing the bicycle and the vehicle respectively.

To study skull behaviour, a double pendulum set-up was used, which would offer one rotational degree of freedom to the skull while ensuring the feasibility of performing controlled measurements (Figure 1). The impacting pendulum had a length of 1.48 m, was made out of steel and had a mass of 14.3 kg, which could be increased up to either 26.4 or 34.7 kg by adding additional weights. The second pendulum was made of aluminum, having a mass of 5.6 kg and a length of 1.28 m. 112 skulls were collected from the department of anatomy of the K.U.Leuven. After decease the bodies of the donors all had been embalmed with a solution of formaldehyde. Upon receipt of the specimen, the scalp and intracranial contents were removed by immersing the heads in water at 80°C during approximately 6 hours. To prevent decay, they were stored in a solution of 1% formaldehyde in water. To enable characterization of certain geometrical features and material properties, computed tomography scans were taken of all 112 skulls. Impacts were given with a low (1.6 to 3.0 m/s) or high (3.9 to 4.6 m/s) velocity.

![Figure 1. Experimental set-up.](image)