

RUGBY AND CERVICAL SPINE INJURY

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The purpose of this presentation is to present an overview about cervical spine injuries and rugby. We focus first on global epidemiology of such injuries and on the associated injury mechanisms. Then we present the different actions developed during the last decades in order to reduce the number of injuries. In a final part, a new approach based on Finite Element Modelling is proposed to identify links between injury risks and specific anatomy.

KEY WORDS: Rugby, Cervical Spine Injury

CERVICAL SPINE INJURIES IN RUGBY: Injuries of the spinal cords are one of the first causes of major sport injuries, but nowadays there are no curative or orthopaedics treatments for this kind of traumas. Systematic hospitalization and ambulatory management made a huge progress at relieving the injured people. Indeed, not only does it have an important financial cost but it also has devastating effect on a physical, social and psychological level, for the victim and its family as well. In developed countries, the incidence of such injuries is about 40 cases for one million, representing at least 10 000 North Americans and 11 000 Europeans each year (McDonald & Sadowsky, 2002, Wyndaele & Wyndaele, 2006). For example, there were 37 cases of catastrophic cervical spine injuries in French rugby player between 1996 and 2006. The decreasing of the incidence of such injuries during these 10 years shows the influence of the measures of prevention and of the modifications of rules (Bohu et al., 2009). However, Hermatus *et al.*, based on a retrospective study of 138 cases, shown an increase of cervical spine injuries between 1980 and 2007 (Hermanus, Draper, & Noakes, 2010). Furthermore, they identified that 61% injured players had a catastrophic outcomes after 12 months, including 8% who died; young players between 16 and 17 years old seem to have the higher risk of cervical spine injuries (Hermanus et al., 2010; MacLean & Hutchison, 2012).

INJURY MECHANISMS: In a recent review, Kuster *et al.* shown that facet dislocations were identified as the most common cervical trauma and that C4/C5 and C5/C6 cervical segments are the most often injured (Kuster, Gibson, Abboud, & Drew, 2012). They also underline that the majority of cervical spine traumas are more the results of buckling (compression and flexion) than hyperflexion. Furthermore, the players' field positions not seem to be correlated with the incidence of the cervical injuries. That can be explained because before the 2000s most of the cervical spine injuries occurred either during scrum engagement or scrum collapse, with a greater incidence for the hooker. Nowadays, the cervical spine injuries occur more often during tackle. However, MacLean *et al.* underlined that spinal cord injuries were significantly more common during scrum accident (MacLean & Hutchison, 2012).

PREVENTION AND ACTIONS: As sport accidents are the first cause of spine injury for people under 30 years old, national sport federations developed a set of actions in order to reduce the incidence of these injuries:

- Creation of national registers to collect epidemiology data and to develop tools for accident analysis (Bohu et al., 2009; Hermanus et al., 2010).
- Modification of sport rules. Even if it seems to be the key factor, there is a challenge to modify the rules without denaturing the game (Kuster et al., 2012; Rihn et al., 2009; Tator, Provvienza, & Cassidy, 2009).

- Generalization of safety equipment wearing; as an example, using mouthguard could help to better protect the neck by increasing the contraction of cervical spine muscles (Cross & Serenelli, 2003).
- Development of awareness campaigns in order to educate players to good sports practices and safety (Donaldson & Poulos, 2014).

ACTUAL GUIDELINES: the risk of injury of a given rugby player has to be assessed by a medical doctor for each game season, but few guidelines have been developed for such clinical examination (Torg et al., 1996). The French Rugby Federation (FFR) has designed very strict rules in order to better identify the risk (Bernard et al., 2009); a MRI exam is now mandatory for each professional player and those over 40 years old. Then players are split into three categories: absence of contraindication, relative and strict contraindications (Table 1 gives some clinical aspects associated with these 3 groups).

Table 1
Injury risk assessment for cervical spine of rugby players.

Absence of contraindication	Relative contraindication	Strict contraindication
Resolvent radiculalgia	Chronic radiculalgia	Permanent neuronal deficit
Mild sprain	Short apraxia	Apraxia (> 36h or > 3 times)
Consolidated fracture	Up to 2 cervical fusions	Pyramidal syndrome
Foraminal stenosis	Canal stenosis with CSF	Laminectomy
Non-compressive hernia		Up t 3 cervical fusions
		Chiari syndrome, syrinx

Even if this classification could be helpful, most of the proposed risk factors are not clearly linked with the injury risk. For example, the cervical canal stenosis is a very frequent condition amongst rugby players (Bernard et al., 2009; Castinel et al., 2008) and it is obvious that it will increase the risk of apraxia accident; but there is no clear link with catastrophic injuries. Furthermore these fatal accidents are always due to osteoarticular failure. In order to address this previous issue, it could be interesting to determine a set of morphological parameters associated to the risk of injury and easily identified during the clinical evaluation.

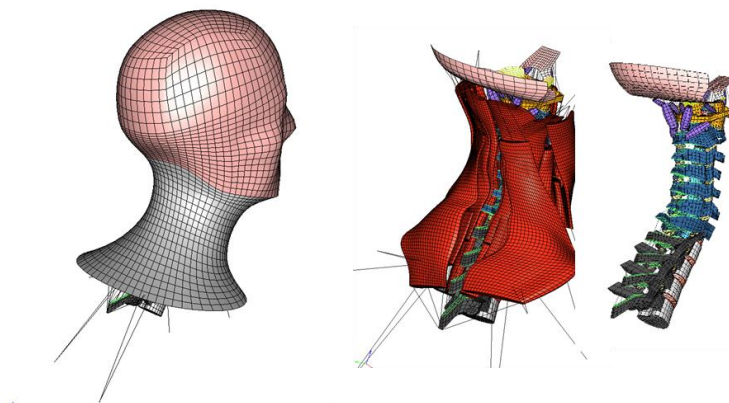


Figure 1: Example of Parametric and Subject Specific Modelling of the cervical spine.

MODELING AND BIOMECHANICS: the cervical spine has a wide interindividual variability. In order to analyse the influence of this variability on the risk of injury, there is a need of a sensitivity analysis. This kind of study could be developed using Finite Element Modelling. A previous study design by Frechede *et al.* shown the influence of the curvature on the mechanical behaviour of cervical spine and then on the risk of injury (Frechede, Bertholon, Saillant, Lavaste, & Skalli, 2006). The method developed at the Institut de Biomecanique

Humaine Georges Charpak allows to design Parametric and Subject Specific Modeling (PSSM) of the head / neck complex could allow this numerical sensitivity analysis (Laville, Laporte, & Skalli, 2009) (Figure 1). This method as already shown the influence of the geometry on the motion patterns.

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