PROTOCOLS

Lap-belt syndrome

Principal investigator

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Background

Seat-belt use has clearly reduced fatalities in motor vehicle crashes. Studies report a 40 to 50% decrease in mortality, as well as a decrease in the severity of injuries. However, with the increasing use of seat belts over the last decades, a new association of injuries has emerged among adults and children involved in motor vehicle crashes. The 'lap-belt syndrome' was first described by Garrett and Braunstein in 1962[1] and refers to injuries to the abdominal viscera and to the lumbar spine associated with seat-belt restraints. Typically, it involves a tear or perforation of the intestine and its mesentery which is accompanied by fracture, distraction, or dislocation of the mid-lumbar spine. These complex injuries are caused by rapid deceleration characteristic of high-impact crashes, resulting in sudden flexion of the upper body around the fixed lap belt, and consequent compression of the abdominal viscera between the lap belt and the spine. The mechanism of the lumbar spine injuries appears to be a hyperflexion of the spine around the lap belt subjecting the vertebrae to tension stress and distraction. Children are especially vulnerable to these injuries. Their intra-abdominal organs are less protected by the thorax and pelvis, they have a lower centre of gravity, and their iliac crests are less developed than those of adults, allowing the belt to ride up over the abdomen.

To date, very few paediatric studies on the incidence of the lap-belt syndrome have been undertaken. In fact, most current knowledge on this syndrome comes from case reports or studies done in limited regional areas. The number of cases in these studies was relatively low, ranging from 10 to 50 cases over several years. More recently, however, the Centre hospitalier universitaire de Sherbrooke

reported 10 children involved in three different motor vehicle crashes in the same year, eight of whom had characteristic lap-belt syndrome. In this case series, four of the five children with lumbar spine fractures remained paraplegic.[2] The incidence of lap-belt syndrome extrapolated from one study was 0.4% of the paediatric trauma admissions. With this estimate, the incidence in the Canadian paediatric population should be approximately 160 cases per year. School-aged children aged five to 12 years old are at greater risk of having this association of injuries, as they have outgrown their child-safety seats but are not yet tall enough to fit properly into restraints designed for adults. Although rare, this syndrome can be of great clinical importance, as permanent neurologic deficits have been associated with lumbar spine injuries in the lap-belt syndrome. Newman et al reported an incidence of 25% of paraplegia among patients with lumbar spine fractures in lap-belt syndrome.

Methods

Through a one-time survey of CPSP participants undertaken in January 2003, the CPSP was able to confirm that paediatricians do see children with lap-belt syndrome at some point during their hospitalization. At the start of the study, all paediatricians will be mailed the study protocol and case definition. Afterwards, participants will receive monthly report forms asking for lap-belt syndrome cases. For each new case identified, participants will be asked to complete a detailed questionnaire. Provincial paediatric death review committees, medical examiners and coroners will also be contacted.

Objectives

1. Obtain epidemiologic data on the incidence and pattern of injuries encountered in the lap-belt syndrome.
2. Identify at-risk age groups among the Canadian paediatric population.
3. Supply data that will help develop new strategies to adequately protect children in motor vehicles.
4. Promote education and awareness of this rare condition among health-care professionals.

Case definition

Report any child up to 18 years of age inclusively, restrained in a motor vehicle at the time of a crash (seat restraints are defined as: child safety seat, booster seat, lap belt only, or lap and shoulder belt), with either:

1. **An abdominal injury**, as determined by operation, ultrasound or abdominal CT scan. Splenic, liver, kidney and duodenal injuries will be graded according to their specific injury scale.[3] (See tables 1-4.)

Lap-belt syndrome (continued)

Abdominal injuries include those involving:

- small intestine, colon
- spleen
- kidney
- liver
- pancreas
- mesentery
- bladder
- uterus
- any vascular structure within the abdominal cavity

or

2. Thoraco-lumbar spine injuries

Major spinal injuries:

- compression fractures
- burst fractures
- seat-belt type injuries
- fracture dislocations

Minor spinal injuries:

- fracture of transverse process
- fracture of articular process
- spinous process fractures
- pars interarticularis fractures

Duration

September 2003 to August 2005

Expected number of cases

Approximately 160 cases per year

Ethical approval

Centre hospitalier universitaire de Sherbrooke

Data analysis and publication

Data will be collected according to the 'Recommendations for Uniform Reporting of Data following Major Trauma – The Utstein Style (An initiative)' and will focus on patient characteristics, crash characteristics, type of restraint, description of injuries, and long-term complications. The patients' functional outcome will be evaluated using established criterias. The AIS (Abbreviated Injury Scale), a scoring system, will be used to determine the severity of injuries.

Incidence results will be presented as rates for 1,000 children per year, calculated from population data published by Statistics Canada. With the contribution of the data from Transport Canada, the total number of crashes causing death or injuries will be categorized for three age groups (0 to 4, 5 to 12 and 13 to 18 years). The different abdominal and spinal injuries will be analysed according to their relative frequency.

An epidemiologist from the Centre hospitalier universitaire de Sherbrooke will also contribute to this data analysis.

Data will be published in a peer-reviewed journal upon completion of the study.

References

1. Garrett JW, Braunstein PW. The seat belt syndrome. *J Trauma* 1962; 2: 220.
2. Santschi M, Laflamme S, McFadden N, Echavé V, Cyr C. The spectrum of lap belt injuries sustained by multiple victims in motor vehicle crash. *Paediatr Child Health* 2002; 7(Suppl A): 31A.
3. Moore EE et al. Organ injury scaling: spleen, liver, kidney. *J Trauma* 1989; 29(12): 1664.

Additional references are available from the investigator or the CPSP office.

Table 1: Splenic injury scale

	Grade	Injury description
I	Hematoma	Subcapsular, nonexpanding, < 10% surface area
	Laceration	Capsular tear, nonbleeding, < 1 cm parenchymal depth
II	Hematoma	Subcapsular, nonexpanding, 10-50% surface area; intraparenchymal, nonexpanding, < 2 cm in diameter
	Laceration	Capsular tear, active bleeding; 1-3 cm parenchymal depth that does not involve trabecular vessel
III	Hematoma	Subcapsular, > 50% surface area or expanding; ruptured subcapsular hematoma with active bleeding; intraparenchymal hematoma > 2 cm or expanding
	Laceration	> 3 cm parenchymal depth or involving trabecular vessels
IV	Hematoma	Ruptured intraparenchymal hematoma with active bleeding
	Laceration	Laceration involving segmental or hilar vessels producing major devascularisation (> 25% of spleen)
V	Laceration	Completely shattered spleen
	Vascular	Hilar vascular injury that devascularizes spleen

Lap-belt syndrome (continued)

Table 2: Liver injury scale

	Grade	Injury description
I	Hematoma	Subcapsular, nonexpanding, < 10% surface area
	Laceration	Capsular tear, nonbleeding, < 1 cm parenchymal depth
II	Hematoma	Subcapsular, nonexpanding, 10%-50% surface area; intraparenchymal, nonexpanding, < 2 cm in diameter
	Laceration	Capsular tear, active bleeding; 1-3 cm parenchymal depth, < 10 cm in length
III	Hematoma	Subcapsular, > 50% surface area or expanding; ruptured subcapsular hematoma with active bleeding; intraparenchymal hematoma > 2 cm or expanding
	Laceration	> 3 cm parenchymal depth
IV	Hematoma	Ruptured intraparenchymal hematoma with active bleeding
	Laceration	Parenchymal disruption involving 25-50% of hepatic lobe
V	Laceration	Parenchymal disruption involving > 50% of hepatic lobe
	Vascular	Juxtahepatic venous injuries (i.e., retrohepatic vena cava / major hepatic veins)
VI	Vascular	Hepatic avulsion

Table 3: Renal injury scale

	Grade	Injury description
I	Contusion	Microscopic or gross hematuria; urologic studies normal
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration
II	Hematoma	Nonexpanding perirenal hematoma confined to renal retroperitoneum
	Laceration	< 1 cm parenchymal depth of renal cortex without urinary extravasation
III	Laceration	> 1 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation
IV	Laceration	Parenchymal laceration extending through the renal cortex, medulla, and collecting system
	Vascular	Main renal artery or vein injury with contained hemorrhage
V	Laceration	Completely shattered kidney
	Vascular	Avulsion of renal hilum, which devascularizes kidney

Table 4: Duodenum injury scale

	Grade	Injury description
I	Hematoma Laceration	Involving single portion of duodenum Partial thickness, no perforation
II	Hematoma Laceration	Involving more than one portion Disruption < 50% of circumference
III	Laceration	Disruption 50-70% circumference D2 Disruption 50-100% circumference D1, D3, D4
IV	Laceration	Disruption > 75% circumference of D2; involves ampulla or distal common bile duct
V	Laceration Vascular	Massive disruption of duodenumpancreatic complex Devascularisation of duodenum