Chapter 6

Bicycle-spoke injuries among children:
accident details and consequences


Abstract

Objective: To describe the accident details and the effects of bicycle-spoke accidents on the physical and psychosocial functioning of children.

Design: Retrospective, descriptive

Methods: The parents of 87 children aged between 1-12 who came to the Department of Traumatology of University Hospital Groningen with bicycle-spoke injuries between 1 January 1998 and 31 October 1999 were asked to complete a questionnaire on the accident details, quality of life and functional health status (behavior) of their child in January 2000.

Results: Eighty-seven children fulfilled the inclusion criteria: 44 boys and 43 girls, with a mean age of 4.4 years (SD: 1.6, range: 1.4-10.2). Fifty-nine parents filled out the questionnaire (68%). A quarter of the children had been transported in a bicycle-seat (25%) and half of the children (51%) were seated on the carrier without any foot supports. Twenty-four percent of the bicycles were equipped with unbroken coat-guards. The younger children (1-5 years of age) had significantly lower motor function scores compared with the reference group \((p<0.001)\). Compared with the reference groups, the study population did not have significantly lower scores for the other quality of life domains. Eight parents (14%) attributed behavioral problems to the bicycle-spoke accident.

Conclusion: Not all children had fully recovered one year after the bicycle-spoke accident. The sequelae included physical as well as behavioral aspects of functioning. The bicycles lacked adequate protective features.
Chapter 6: Bicycle-spoke injuries

Introduction

A bicycle-spoke injury is an injury of the foot, ankle and/or lower part of the leg caused by the entrapment of a person’s foot between the frame of a bicycle and usually the spokes of its rear wheel (Figure 1). Children constitute the largest group of victims of bicycle-spoke accidents.1,2

It has been estimated that 70-80% of bicycle-spoke injuries in children are preventable.1 However, bicycle-spoke accidents are still frequently observed and the number of incidents has even increased.3 Between 1984-1988 an average of 4500 patients were treated at Accident and Emergency Departments in the Netherlands each year for bicycle-spoke injuries.1 This figure was 6800 in 1995-1996.2 The patients were predominantly children up to 14 years of age.

Figure 1. Bicycle spoke injury: a foot entrapped between the frame of a bicycle and the spokes of its rear wheel.

Bicycle-spoke incidents can result in relatively severe injuries, including fractures, areas of full-thickness skin loss and soft tissue damage.4-10 It may take a number of days to weeks before the true severity of the injuries becomes apparent.4,5,9,10 In view of the relatively severe injuries caused, and the length of time taken to complete healing, ranging between a number of
children with bicycle-spoke injuries can be expected to experience limitations in functioning after the incident. However, the degree to which bicycle-spoke injuries affect the child’s functioning has received little to no attention in an outcome study.

The purpose of the present study is to describe the accident details of bicycle-spoke incidents in children, and to examine the functional health status and the health-related quality of life of children after bicycle-spoke injuries.

**Patients and Methods**

The study population consisted of all children of 1-12 years of age treated at the Department of Traumatology of University Hospital Groningen, the Netherlands, between the first of January 1998 and 31 October 1999. Only those children who had incurred their bicycle-spoke injuries three months before the follow-up assessment were included. These patients were identified through a computerized trauma registration system: the ‘Registratie Letsels en Ongevallen Groningen’ (RLOG) of the Department of Traumatology of University Hospital Groningen. General characteristics of the study population, including age, gender and injury diagnoses, were also obtained from the RLOG. In the RLOG, bicycle-spoke accidents have the E-code 82681. Medical records were used to calculate the treatment duration (i.e. the number of days until the final outpatient contact).

The accident details and the child’s functioning were assessed with a postal questionnaire that was sent to the parents of the study population in January 2000. The following accident details were collected: the rider of the bicycle, the owner of the bicycle, the position of the child on the bicycle, and the presence of foot rests and unbroken coat-guards. To explore the impact of the bicycle-spoke incident on the child’s functioning, the questionnaire inquired if, during the previous two weeks, the bicycle-spoke accident had caused pain or discomfort, affected the child’s hobbies or activities, or caused anxiety in the child for being transported on a bicycle after the incident. Furthermore, the questionnaire included the Functional status II(R) (FS II), and the TNO-AZL preschool quality of life questionnaire (TAPQOL), or the TNO-AZL children’s quality of life questionnaire (TACQOL). These standardized questionnaires have proven to be reliable and valid instruments for the assessment of the child’s functional health status and the child’s health-related quality of life, respectively.

The FSII contains 14 questions about the child’s behavior, to ascertain the child’s functional health status. The FS II distinguishes between general
functional status limitations (FS-general score) and functional status limitations caused by an illness, i.e. illness-specific problems (FS-specific score). In the present study, behavioral problems specifically attributable to the bicycle-spoke incident are scored in the FS-specific score. Both scores range from 0 to 100. Higher scores represent a better functional health status.

Depending on the age of the child, the TAPQOL (1-5 years) or TACQOL (6-15 years) questionnaire was applied to assess the child’s health-related quality of life. The TAPQOL questionnaire contains 12 domains: pulmonary problems, stomach problems, skin problems, sleep, appetite, problematic behavior, positive mood, anxiety, vitality, social functioning, motor functioning and communication. The domain scores range from 0 to 100. The TACQOL questionnaire includes the following 7 domains: physical complaints, motor functioning, autonomy, cognitive functioning, social functioning, positive emotions and negative emotions. The first 5 domain scores range from 0-32. The scores of the latter two emotion domains range from 0-16. Higher scores on both questionnaires indicate a better health-related quality of life. We added a question to the TAPQOL and TACQOL domains to verify if problems could be attributed to the bicycle-spoke incident.

To draw comparisons between the functional health status and the health-related quality of life of our study population and reference groups, the following reference data were available: FSII data of 114 children aged 2-8 years, TAPQOL data of 222 children aged 2-4 years, and TACQOL data of 657 children aged 6-7 years.

Statistical Analysis
The categorical and continuous variables were analyzed with chi-square tests and t-tests, respectively. The study population and reference groups TAPQOL and TACQOL health-related quality of life domain scores were compared with analyses of covariance, with the children’s age and gender as covariates. The Bonferroni post-hoc test was used in case of multiple comparisons. A $p$ value $< 0.05$ was considered statistically significant.
Results

Study population

Eighty-seven children met the inclusion criteria of the study, of which 44 (51%) were boys. The children had a mean age of 4.4 years (SD:1.6; range:1.4-10.2) at the time of the incident (Figure 2).

Overall, the patients had 107 injury diagnoses of the lower extremities. One quarter of the children (22/87) had fractures of a lower extremity (Figure 3). The other injuries that affected the lower extremities were 41 deep excoriations, 21 lacerations (Figure 3), 13 contusions, and nine distortions. The patients had been under treatment for an average of 17.4 days (SD:16.6; range: 0-85).
Fifty-nine parents completed the questionnaire (68%). The participating parents’ children were, on average, 4.5 years old (SD:1.3; range 1.5-8.1) at the time of the bicycle-spoke incident and half of these children were boys (30/59). The responding parents’ children had a longer mean treatment period (mean 20.2 days; SD:18.3), compared to the group of non-respondents (mean 11.4 days; SD:10.2; p=0.005). The groups did not differ with respect to age or gender distribution (p>0.05).

**Accident characteristics**

In two-thirds of the accidents, one of the parents had been the cyclist (39/59). In the other cases, the child was being transported by another adult (12/59; 20%) or another child (7/59; 12%).

At the time of the incident, the children were seated on the carrier (39/59; 66%), in a bicycle seat on the carrier (15/59; 25%), or on the crossbar (5/59; 8%). Overall, half of the patients had been seated on the carrier without any foot supports (30/59). Three-quarters of the bicycles involved were not equipped with intact coat-guards (45/59).
In 22 of the 59 incidents, the child was carried on a bicycle that was not owned by one of the parents. In the remaining 37 bicycle-spoke accidents, one of the parents’ bicycles had been used. Two-thirds of these bicycles were not equipped with a bicycle-seat (24/37; 65%), and approximately three-quarters of the parental bicycles lacked unbroken coat guards (27/37; 73%) and foot supports (29/37; 78%). The majority of the children transported on a bicycle belonging to neither parent were seated on the carrier without any protective measures (16/22; 73%).

Consequences
The mean follow-up time was 13.2 months (range: 3.3-24.7 months). Five parents indicated that their child still experienced slight discomfort or pain due to the bicycle-spoke injury. None of the children experienced problems in performing hobbies or activities because of the spoke-injury. Half of the children (29/59) felt anxious about being transported on a bicycle again after the accident. Two children continued to have these feelings at the follow-up assessment.

The FS-general score of the children with bicycle-spoke injuries did not differ from the FS-general score of the reference group (both groups median=89.3). However, eight parents (14%) reported a submaximum FS-specific score. These parents attributed one (n=1), two (n=4), or more than three (n=3) behavioral problems to the bicycle-spoke incident.

No differences emerged between the mean TACQOL health-related quality of life scores of the study population children aged six years or older at follow-up, and the respective scores of the reference group.

The children with bicycle-spoke injuries younger than six years of age at follow-up had a significantly better mean score in the TAPQOL stomach problems domain compared with the reference group children (study population: mean: 93.02 (SD: 12.3) versus the reference group: mean: 90.6 (SD: 14.0); p=0.042), but a significantly lower average score in the motor functioning domain (study population: mean: 95.6 (SD:10.4) versus the reference group: mean: 99.3 (SD:3.0); p<0.001). After Bonferroni correction for multiple comparisons, only the difference in the motor functioning domain remained statistically significant. Eight parents attributed submaximal functioning on at least one TAPQOL or TACQOL domain to the bicycle-spoke accident. Five of these eight parents attributed impaired motor functioning to the accident.
Overall, 11 parents (19%) indicated that problem behavior (FS II) and/or reduced functioning as measured by the TAPQOL/TACQOL questionnaires was a consequence of the bicycle-spoke accident.

Discussion

Children aged 2-6 years run the highest risk of suffering bicycle-spoke injuries. In the present study, almost 90% of the children were within this age range. Older children run a lower risk of bicycle-spoke injuries as they are more often cyclists themselves.

According to Article 61 of the Dutch Traffic Rules and Signs Regulations Act 1990, children under the age of eight may only be seated on a bicycle if that seat be purpose-built and safe, with adequate supports for their back, hands and feet. Our results showed that a large proportion of the young patients had been carried on a bicycle with few or no preventative features. This finding corresponds with previous Dutch research on bicycle-spoke injuries in children. This raises the questions what has been done about previous recommendations concerning preventative measures, to what extent has the use of preventative measures changed in the past years, and are these measures effective? To answer these questions, a comparative study needs to be performed on parents of children with and without bicycle-spoke injuries. These parents should be asked which preventative measures they had installed on their bicycles.

To reduce the number of bicycle-spoke accidents, the Dutch and/or European bicycle-seat norms need to be developed and adopted further. These conventions can form the basis of legal regulation on the sale of bicycle-seats. Furthermore, attention should be paid to the further development of adequate spoke-guards. Spoke-guards need to be of adequate size and strength, requirements that are not met by regular coat-guards.

The results showed that the majority of the bicycles involved that were not owned by one of the parents lacked measures to prevent bicycle-spoke entanglement. However, this was also the case for many of the parental bicycles. Therefore, the installation of spoke guards on bicycles by manufacturers as standard seems an advisable regulation.

The mean treatment period of 17.4 days seems short compared with previous studies that reported an average healing time of between 17 and 56 days. However, healing time and the time that a child is under treatment are not equivalent. We used the final outpatient visit as reported in the medical records to determine the treatment period. On the other hand, in three of the five previous studies, the parents were asked after the time
needed for complete healing. In addition to the healing of the injury itself, the parents are likely to have included the child’s recovery in terms of the child’s functioning in various situations. This may have resulted in an increased estimate of the recovery time.

Apart from the healing time, the literature scarcely reports on the consequences of bicycle-spoke accidents for the child’s functioning. Only one study indicated that 13% of the children had not yet resumed their normal activities up to six weeks after a spoke injury. This study provides a more detailed description of the children’s functioning at an average of one year after the bicycle-spoke accident. Compared with the reference groups, only the group of children aged five years and younger at the follow-up assessment showed statistically significant lower scores in the motor functioning domain (walking, running, walking up stairs without help, and balance). However, not only motor problems were attributed to the bicycle-spoke accident but also behavioral problems, including poor sleep, tiredness, and moodiness. Therefore, in the assessment of a child’s recovery, and in informing the parents, not only the healing of injuries and physical functioning should be evaluated, but any possible behavioral problems as well.

A shortcoming of our study is the fact that the respondents had a relatively longer term of treatment compared with the non-respondents. This difference could lead to an overestimation of the sequelae of bicycle-spoke accidents. We expect this rarely to be the case, however, because further analyses indicated that the duration of treatment was not statistically related to the behavior of the total study population or the motor functioning of the younger children.

Our findings, that almost one out of every five children experienced adverse effects because of the bicycle-spoke accident at, on average, one year after the incident, as well as the fact that annually, thousands of children are treated for bicycle-spoke injuries, illustrates the adverse impact of bicycle-spoke injuries. Paying more attention to the prevention of bicycle-spoke accidents, and the consistent use of protective features could avoid a lot of distress.

References