

Bicycle Spoke Injuries

Magne Juhl, Department of Orthopaedic Surgery,
Odense University Hospital, Odense, Denmark.

Records of bicycle spoke injuries have before been made by the Odense University Hospital (4,5), and we have now thought it of interest to make a more thorough analysis of how and why the accidents occur.

Bicycle spoke injuries are lesions of the crus or foot in children transported as passengers on a bicycle; the lesions occur if the child's foot is caught in the wheel of the bicycle.

The Danish Road Traffic Act (2) has the following passage on the transportation of children as passengers on bicycles: A bicycle may be used only for the transport of the number of persons it is intended for. However, two children under 6 years of age may be carried on the bicycle when special seating arrangements have been made providing protection against the spokes, and when the cyclist is more than 15 years of age.

Total material

From July 1970 until 18 April 1974 all bicycle spoke injuries received for primary treatment at the casualty ward in Odense were recorded on a special summary form. The traffic injury records of the Odense University Hospital (7) have for the period from 19 April 1974 until 1 April 1975 been investigated to extract instances of bicycle passengers injured in single accidents, and there is probably a certain under-recording of this type of accident. From 1 April 1975 the cause of injuries has been recorded by means of EDP (the WHO E-code) in all primary contacts made at the casualty ward, and this material has been used until 31 December 1975.

Frequency

In table I is shown the frequency of bicycle spoke injuries treated at the Odense University Hospital from 1971 until 1975 compared with the frequency for some years in the 1950's. The groups of material are not completely comparable as the latest material covers children of the ages 0 to 15 years against an upper limit of 7 years in the earlier groups of material. Among the 215 from the 1970's, however, only 7 were older than 7 years, and in 14 cases information on age is not available.

It will be seen that in the 1970's there were approx. 50 cases a year against approx. 80 in the 1950's. The Odense University Hospital covers approx. 4,5% of the Danish population, and if the area can be considered as representative, the figures imply that in Denmark about 1100 children still suffer bicycle spoke injuries every year. Figures are not available to show how many children are transported as passengers on bicycles.

Table II shows the distribution of accidents on the months of the year, and it is seen that bicycle spoke injuries occur especially in summer. Distribution according to age is shown in table III. The average age was 3,2 years. 95 were boys and 116 girls.

After-Examination

As it was judged difficult to reconstruct the chains of events in older accidents, the accidents from 1974 and 1975 were selected for more thorough analysis. This material consisted of 65 patients whose available case records were studied. Questionnaires were filled in in home interviews in 57 cases. In 3 cases corresponding information was obtained by letter and telephone. Four were untraceable on account of moving, and 1 refused to co-operate.

Thus explicit information is available on 60 of the 65 accidents (92,3%) from 1974 and 1975.

Lesions

In 57 of the 60 cases X-ray examination of the affected extremity was indicated, and fractures were found in 4 (6,7%). In a material from the Odense University Hospital from 1954 till 1956 (5) fractures were found in 41 out of 163 patients (25,2%). The number of fractures varies greatly in a number of works (1,3,9,10) dependent on the selection of the groups of material.

The right and the left foot were affected with equal frequency. Most often the soft-tissue lesion was found in the lateral mallei. Twentysix cases showed lesion of the left lateral malleus and 23 cases of the right, and in 39 cases there was only lesion localized on the lateral mallei.

As a result of the lesions 25 children were hospitalized for an average of 5½ days. Only 3 still suffered inconvenience at the after-examination 2 to 23 months after the accidents. Two limped when tired and 1 tended to twist his ankle without any objectively demonstrable looseness.

Detailed Circumstances at the Occurrence of the Accidents

The errand of the cyclists at the occurrence of the accidents is shown in table IV, and table V shows who rode the bicycle. There were 33 female and 27 male cyclists. Among the cyclists 17 were below the age of 15 and thus below the age permitted by the Road Traffic Act.

The type of bicycle is mentioned in table VI. Among the 11 children's bicycles 9 were used for play and 2 for errands when the accident occurred.

Use of children's seats and dress-guards is shown in table VII. In 20 cases there was a seat on the bicycle, but in only 2 cases together with a dress-guard, although none of the seats alone fulfilled the demands of sufficient protection against the spokes. In one case with seat as well as dress-guard on the back

of the bicycle there were no foot rests, and the child, who was approx. 5 years old, was so big that the feet extended below the dress-guard. In the other case, with an 18-month-old child it was not possible to get more detailed information on the accident.

Out of 40 children not sitting in a children's seat, 37 sat on the carrier, 1 was standing on the hub nuts of the rear wheel, 1 sat on top of a satchel on the carrier, and the last one on the twin saddle of a small boys' bicycle.

The after-examination included an investigation of whether the accident resulted in purchase of seats and dress-guards. The result is seen in table VIII. Five mothers who were not there themselves at the accident bought both seats and dress-guards for their own bicycles. Altogether the parents have after the accident bought 19 dress-guards and 12 seats so that approximately half the parents have procured relevant safety equipment.

To the question why the child's foot was caught in the bicycle wheel the answers were as shown in table IX. In approx. one third of the cases the cause has not been elucidated. In many of these cases the answer was that the child suddenly screamed, and/or that a sudden resistance was felt in the wheel. In at least 5 cases the bicycle was being pushed, showing that the lesion may occur at a low speed.

In table X is shown where on the bicycle the foot was caught. Sixty-one points are mentioned as in one accident the foot got caught between rear wheel, part of the children's seat, and frame. Most were caught between rear wheel and frame.

No reliable difference in lesions has been proved in relation to footwear. Bicycle spoke injuries are also seen in spite of use of leather boots.

In 42 cases at least one of the parents had before the accident heard of the risk of bicycle spoke injuries. A total of 4 fathers and 3 mothers had themselves had a foot caught in a bicycle wheel, but none of these parents rode the bicycle at the accident.

Discussion

Carstam (1) says that bicycle spoke injuries most often occur when children sitting astride a carrier with abducted legs get their feet caught in the spokes of the bicycle. The heel is caught and carried forward by the spokes, making the foot rotate, and the heel gets stuck between spokes and seat-stay. This is consistent with my findings as in exactly this mechanism the lateral malleus is caught and damaged. As mentioned there was in 49 out of 60 cases lesions of the lateral malleus, and in 28 cases it was mentioned that the foot had been caught between rear wheel and frame.

The incidence of bicycle spoke injuries has fallen, cf. table I, to approximately half since 1960. In that same period the number of children injured as passengers in cars has increased. Nordentoft et al. (6) found an increase in number of children injured in cars from 26 to 96 a year in that same area

from 1960 to 1972. Use of dress-guards and seats is not stated in the earlier groups of material from Odense and not known in traffic as a whole.

The lesions seem to have become less serious as only 6,7% had fractures against 25,2% in an earlier material from the same hospital (5). If this is a measure of people coming to the casualty ward with slighter injuries now, the drop in number of bicycle spoke injuries is even greater. It must be stressed, however, that the softtissue lesions may be serious with necrosis and protracted healing.

There are still approximately 1100 children sustaining bicycle spoke injuries a year in Denmark. Diagram I shows suggested precautions to reduce that figure. The most important prophylaxis is the manufacturing of a sufficiently safe seat. That seat has not yet been designed. Carstam (1) has suggested placing the children in a seat on the handle bars with gully-shaped guards for the legs. Pontén (8) and Strauch (9) have suggested that the factory provide all bicycles with dress-guards or some similar protection for the legs.

With the present technological level it must be possible to manufacture a seat with sufficient protection for the legs. The leg protection must be an integral part of the seat; this would prevent what happened in several cases in this material, namely that people move the seat, but not the dress-guard, from one bicycle to another.

Constant, repeated information should be given on the risk of bicycle spoke injuries to children transported on bicycles. The information may be given as shown in diagram I.

Literature

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Table I. Frequency of bicycle spoke injuries treated at the Odense University Hospital. Note the difference in ages. In the present material, however, only 7 were above 7 years of age, and for 14 the age is not available.

Time	number a year	material	age
1.IV.1954-1.IV.1956	81,5	Koelle-Joergensen & Budtz-Olsen (5)	0-7 years
1.IV.1959-31.III.60	80	Koelle-Joergensen (4)	0-7 years
1971	46		
1972	46		
1973	58		
1974 (registration incomplete)	17	own	0-15 years
1975	48		

Table II. Distribution of 215 bicycle spoke injuries from 1971 to 1975 upon the months of the year.

Month	number	month	number
January	7	July	37
February	8	August	33
March	9	September	26
April	13	October	11
May	26	November	5
June	33	December	4
		not known	3

Table III. Distribution of age.

age	number	
1	18	
2	47	transport as
3	54	passenger on a
4	32	bicycle permitted.
5	34	
6	6	
7	3	transport as
8	2	passenger on a
9	2	bicycle not
10	0	permitted.
11	1	
12	1	
13	1	
14	0	
15	0	
not known	14	

Table IV. Errand of the cyclist at the occurrence of the accident.

Purpose of the trip	number	
errand	to/from kindergarten/day care	13
	shopping	11
	other errand	7
		31
leisure time	play	12
	sport/outing/visit	17
		29

Table V. Rider of the bicycle.

rider	number
father	14
mother	22
brother/sister	11
playmate	6
other	7

Table VI. Type of bicycle.

type	number
ordinary man's bicycle	14
ordinary woman's bicycle	28
mini bicycle	7
ordinary girl's bicycle	2
ordinary boy's bicycle	8
other (small boy's bicycle with small wheels and twin seat)	1

Table VII. Use of children's seat and dress-guard at the accident.

children's seat	20	position of	back	14
		the seat;	front	3
			on cross bar	3
no children's seat		40		
dress-guard	7	position of	on carrier	5
		the child;	in children's	2
			seat	
no dress-guard		53		
both dress-guard and seat on the back			2	

Table VIII. Equipment of bicycles with seats and dress-guards at the after-examination.

Both seat and dress-guard on back	14
Seat in front	4
Only dress-guard procured, no seat	1
Still only dress-guard on back	2
Still only seat on back	4
Only seat procured, no dress-guard	1
No procurements	7
Not known	2
Matter no longer topical	25
Mothers, not involved, who bought seat and dress-guard	5

Table IX. Causes of the accident.

Causes	number
Sudden, unexpected movement of the bicycle	9
Child jumpy	11
Turned round to look behind	4
Got frightened and pulled back leg	2
Playing (with the wheel)	2
Others	9
Not known	23

Table X. Points of the bicycle where the foot was caught.

Foot caught	number
Between rear wheel and frame	28
" " " " carrier	7
" " " " part of children's seat	1
" " " " chain guard	2
Between front wheel and front fork	6
Spokes only	3
Not known	14

Diagram I. Prophylaxis.

A, Product development and control.

- 1, Design and construction of better seat with built-in safety.
- 2, Minimum demands on safety of seats (specifications given).
- 3, Possibly dress-guards on all adult bicycles.

B, Information (repeated constantly).

- 1, Through the press (preferably every spring).
 - 2, By visiting nurses.
 - 3, By the Danish Council for Greater Road Safety.
 - 4, By the police.
 - 5, By the dealers.
 - 6, Others.
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Summary

A more detailed analysis of 60 consecutive cases of bicycle spoke injuries treated at the casualty ward of the Odense University Hospital showed that a drop in numbers has occurred from 80 to approx. 60 a year from 1960 to the 1970's, corresponding to a drop from approx. 1780 to approx. 1100 on a national basis. At the same time the frequency of fractures has dropped from 25,2% to 6,7%.

In only 2 cases was the bicycle equipped with both seat and dress-guard, and one seat was defective. The accidents caused about half the parents to procure relevant safety equipment.

There is a need for manufacturing of a safe children's seat with built-in protection for the feet, and information must be given on the risk of bicycle spoke injuries to children transported as passengers on bicycles.