ORIGINAL CONTRIBUTION
explosion, tire and wheel;
injury, motor vehicle servicing

Injuries From Tire and Wheel Explosions During Servicing

Study objective: *To evaluate injuries from tire and wheel explosions that occur during servicing.*

Design: *Retrospective analysis of all injury reports from the National Highway Traffic Safety Administration, the Occupational Safety and Health Administration, and the Insurance Institute for Highway Safety.*

Results: *For the period of 1978 through 1987, there were 694 reported injuries from explosions during tire servicing; 143 of them were fatal, resulting mainly from truck tires. Because the three data sources used different methods for case finding and covered different time periods, the actual number of such injuries was probably greater. Head injuries accounted for 78% of the deaths and 24% of nonfatal injuries. The proportion of injuries occurring during tire inflation declined from 51% in 1978 to 33% in 1987 ($P < .05$). Fatal injuries involving single-piece rim wheels increased during the 1980s as multipiece rim wheels were phased out by the trucking industry.*

Conclusions: *Exploding truck tires and wheel rims cause serious injuries. The use of safety cages during inflation as required by a 1980 Occupational Safety and Health Administration standard appears to have reduced injuries during truck tire inflation. The use of helmets during servicing may further reduce serious injuries. [Suruda A, Floccare D, Smith G: Injuries from tire and wheel explosions during servicing. Ann Emerg Med August 1991;20:848-851.]*

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INTRODUCTION

Automobile and truck tires that explode during servicing can cause severe facial, head, and other injuries from flying fragments of the tire or wheel rim.[1] Information from workers' compensation claims analyzed by the Supplementary Data System (SDS) of the US Bureau of Labor Statistics described 2,000 such injuries from 1977 through 1984 for the 33 states participating in SDS (Jack Morrison, statistician, National Institute of Occupational Safety and Health, Cincinnati, Ohio; written communication from SDS regarding workers' compensation data, July 14, 1989). Because of under-reporting and variations in eligibility among states in criteria for including claims in SDS, the actual number of such injuries during this period was probably higher. Few details of the circumstances of injury or type of wheel are available from SDS, and there is little other information available on the frequency of injury from tires and wheels.

Our study was conducted to determine if adequate data were available to analyze trends in injuries from tire and wheel explosions and to identify risk factors and preventive measures.

MATERIALS AND METHODS

All injury reports for the study period were obtained from the Occupational Safety and Health Administration (OSHA), National Highway Traffic Safety Administration (NHTSA), and Insurance Institute for Highway Safety (IIHS). No one source had reports for the entire ten-year period. OSHA compiles reports of work-related deaths in an integrated management information system (IMIS) data base and in a file of fatality/catastrophe telephone reports from OSHA area offices.[2] These reports provided information on injuries for 1980 through 1987 only and covered 47 states

representing 83% of the US workforce;[3] California, Washington, and Michigan maintain investigation files incompatible with the federal system. Only OSHA reports covered injuries from both single-piece wheel and multipiece rim wheel (MPRW) designs.

Reports from IIHS and NHTSA were mainly from before 1985 and included the MPRW design only. IIHS obtained injury reports from trial lawyers, workers' compensation bureaus, and newspaper reports. NHTSA collected injury reports from the major US wheel and rim manufacturers (Goodyear, Firestone, Kelsey-Hayes, and the Budd Company), principally for the years before 1986.

All cases were compiled and matched by geographic location, surname, date of injury, and other identifiers if available to match duplicate reports. The most recent ten-year period, 1978 through 1987, was chosen for analysis because this period contained most of the injury reports that gave descriptive information about the event, perhaps because of the publicity surrounding the IIHS recall effort.

RESULTS

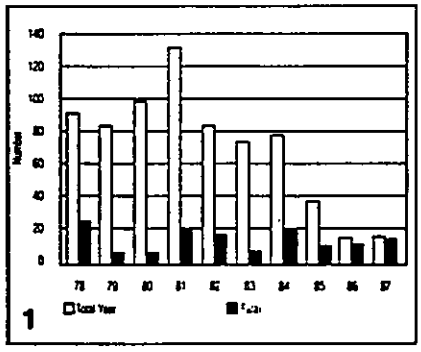
For the ten-year study period, there were 1,010 reports of injuries from the various sources. After matching, 694 separate events were identified. Because the population at risk for the period of reporting was not known, it was not possible to calculate rates of injury. The distribution of the injuries is shown (Figure 1). There were 143 fatalities and 551 nonfatal injuries. Information on single-piece wheel injuries was available only from the OSHA data, which cover 1980 through 1987. Of the 47 fatalities in OSHA reports, 28 involved MPRWs, 12 involved single-piece rims, and seven were unspecified (Table 1). Of the 13 MPRW deaths in OSHA files before 1986, five were also in the IIHS or NHTSA reports.

To indicate how the various data sources collected reports during different periods, a comparison of fatalities reported by all three sources is shown (Table 2). IIHS reports cover the early period, NHTSA reports cover the middle period, and OSHA reports are clustered in the latter years. The completeness of information in each report was quite varied; the NHTSA and IIHS reports contained little information about the injured person.

TABLE 1. *Fatal tire injuries reported to OSHA*

Year	Type of Wheel Rim			
	Multipiece	Single-Piece	Unknown	Total
1980	1	—	—	1
1981	3	—	1	4
1982	1	1	—	2
1983	1	—	—	1
1984	1	2	4	7
1985	6	3	2	11
1986	6	4	—	10
1987	9	2	—	11
Total	28	12	7	47

FIGURE 1. *Reported injuries while servicing tires.*



The sex of the victim was listed in 473 of 694 reports (68%). There were 11 female victims, all bystanders, with four fatalities. The remaining 462 victims were male, with 451 (98%) of these work related.

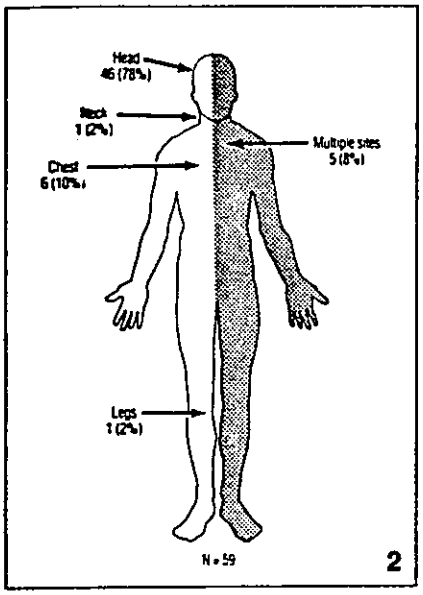
There was little variation in reported injuries by month or day, other than a marked low number of injuries occurring on Sundays. The worker activity was known in 122 of 143 fatal cases; 108 of these (88%) occurred while servicing a tire, with 55% occurring during inflation. There were four fatalities due to welding the wheel while the tire was inflated, an activity prohibited by OSHA as well as by the manufacturers' guidelines. In two deaths, a worker inexperienced in servicing MPRWs mistakenly loosened the bolts holding the rim together while the tire was still inflated, causing an explosion. In 414 nonfatal injuries, 377 (91%) occurred during servicing.

Few reports other than those from OSHA mentioned age. Age was reported for 43 of the 143 fatalities and 23 of the 551 nonfatal injuries. The average age of the fatally injured persons was 36.2 years, with an SD of 15.06 years. The victims with injuries who survived were younger, with an average age of 29.2 and an SD of 11.2 years. This difference was statistically significant ($P < .05$).

The part of body injured was known for 59 of 143 fatalities (41%); 46 (78%) were due to head injury (Figure 2). In the 205 of 551 nonfatal cases (37%) in which information on the anatomic site of injury was available, injuries involved the head (40%), an arm (15%), a leg (13%), and multiple body parts (32%) (Figure 3). Head and arm injuries were most likely to happen while inflating a tire, whereas leg injuries occurred mainly while mounting a tire on a vehicle or rolling it out of the safety cage. Because few reports commented on whether a safety cage was used during inflation of a tire, it was not possible to estimate how many injuries could have been prevented by using one.

DISCUSSION

In the early 1970s, reports of injuries from explosions of a particular type of truck wheel led the NHTSA to conduct investigations of the MPRW.[4] In 1978, the IIHS, having received more than 100 reports of severe injuries from exploding MPRWs, petitioned NHTSA to recall it as an inherently dangerous design.[5] To protect the estimated 322,000 workers in tire shops, in 1980 the OSHA promulgated regulations covering the servicing of MPRWs. Among other requirements, the OSHA standard required that tires be inflated in a restraining device such as a safety cage



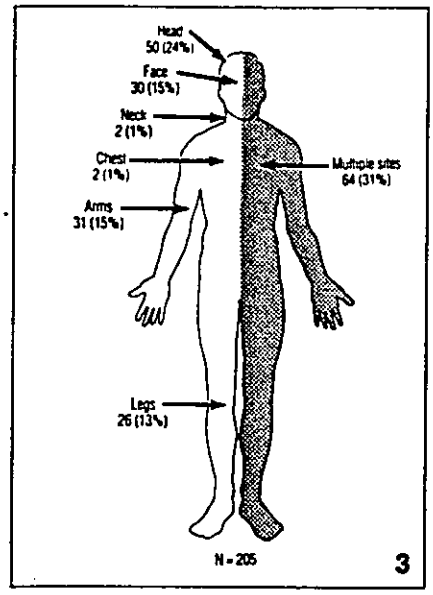


FIGURE 2. *Fatal injuries.*

FIGURE 3. *Nonfatal injuries.*

TABLE 2. *Fatal tire injuries reported to each source*

Year	IIHS	NHTSA	OSHA	All Sources (After Matching)
1978	17	13	NA	22
1979	3	8	NA	10
1980	4	8	1	11
1981	5	15	4	20
1982	4	13	2	16
1983	3	10	1	11
1984	1	12	7	19
1985	0	4	11	12
1986	0	1	10	11
1987	0	0	11	11
Total	37	84	47	143

and that the employer provide a clip-on air chuck with a sufficiently long hose to allow the employee to remain clear of the trajectory of the wheel should it explode while being inflated.[6] Hammering, striking, or forcing of wheel components was prohibited.

The OSHA regulations were later expanded to also cover the servicing of single-piece rim wheels.[7] In 1982, NHTSA announced that it would not issue a product recall for MPRWs because the trucking industry was phasing them out in favor of the single-piece wheel designs, which allowed greater fuel economy, and because OSHA had issued a standard to reduce injuries while servicing tires.[8]

No one agency systematically collects information on tire and wheel injuries. The Consumer Product Safety Commission does not have jurisdiction over or collect data on tires and wheels. Neither NHTSA nor IIHS have collected data for more than short periods, and they have focused on the type of wheel involved, not the site or severity of injury. The OSHA data cover fatal injuries only. Therefore, the quality of the information available for analysis of these injuries was quite varied and incomplete.

The number of fatal and nonfatal injuries found by combining all of the reports appears to show a general decline from 1978 through 1987, with peaking of nonfatal injuries in 1981 (Figure 1). However, this may be an artifact caused by clustering of reports from IIHS and NHTSA. Only one of the data sources is population based and collected reports regularly (OSHA); the others are grouped in time periods corresponding to the 1978 petition for recall (IIHS) or to a 1985 request for data from manufacturers (NHTSA). A comparison of the number of fatalities captured by each data source (Table 2) indicates that the IIHS reports peaked in 1978 and that those requested by NHTSA peaked in 1981.

It is difficult to determine whether the number of injuries has declined over time or whether MPRWs are more dangerous than single-piece rim wheels. The fatalities reported by OSHA show an upward trend with time (Table 1). To what extent the upward trend in OSHA reports indicates better recognition in the years after 1984 due to added information in the data base, better reporting, or an increase in fatalities is unknown. Comparison of the relative number of injuries from explosions of each type of wheel rim is limited because the two largest sources of reports, IIHS and NHTSA, counted MPRW injuries only.

If the apparent decline in MPRW fatalities is real and not a reporting artifact, possible explanations include the introduction of the OSHA standard, an increased use of safety cages and other protective measures, and a reduction in exposure to MPRWs as trucks and buses switched to single-piece wheel designs. For 1985, NHTSA estimated that the percentage of truck, trailer, and bus rims that were multipiece was 51% (updated accident data, NHTSA memo, August 28, 1987), a decline from the 75% figure reported in 1982.[7]

Although most reports did not mention whether safety cages were used, indirect evidence for the increased use of these cages during inflation after the promulgation of the 1980 OSHA standard is the finding that the percentage of total injuries that occurred during inflation compared with other activities such as mounting or demounting declined gradually from 51% in 1980 to 33% in 1987 (χ^2 for trend, $P < .05$).

CONCLUSION

The reports compiled by IIHS, NHTSA, and OSHA present a grim

picture of body parts avulsed or shattered by explosions during the servicing of tires. However, these reports are often incomplete and probably represent only a portion of all such injuries.

Certain conclusions can be drawn from the limited data. Older workers suffered more fatal injuries. After promulgation of the 1980 OSHA standard requiring use of a safety cage during inflation, there was a decline in the percentage of injuries occurring while inflating a tire. However, 40% of servicing injuries occurred while mounting or dismounting a wheel from a vehicle or while rolling it in the shop floor; these injuries would not have been prevented by using a cage. Because 78% of fatalities and 24% of non-fatal injuries were due to head trauma, personal protective equipment in the form of helmets might be a useful safety measure.

Because only OSHA reported deaths from single-piece wheels, and only for a few years, there was insufficient epidemiologic evidence to determine the relative danger of single-piece versus multipiece wheel rims.

How can we obtain better data on tire and wheel explosions that will identify preventive measures? These products are under the jurisdiction of NHTSA, whereas servicing in shops is under the jurisdiction of OSHA. NHTSA requesting this information from the industry on a continual basis, with information concerning the victim as well as the tire and wheel, would provide a start toward epidemiologic surveillance. OSHA investigations allow analysis of fatal injuries, but the number of investigations to date is small. The lack of an adequate surveillance system for these injuries has limited the awareness of the danger from exploding tires and wheels and limited the analysis of risk factors and preventive measures.

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