BURN INJURIES ASSOCIATED WITH THE WATER TANK OF MOTOR FARMING TRICYCLES IN CHINA

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SUMMARY. Burns caused by the water tank of motor farming tricycles have not hitherto been reported. We performed a retrospective study of such burns in 126 patients with complete records in rural areas of China. The majority of the patients were unmarried (59.5%), young (55.6% between 20 and 40 yr), and male (male-to-female ratio, 9:1). The burn accidents occurred mostly (66.7%) during busy spring and summer seasons. The major category of injury mechanism was identified as that of motor-tricycle-related burns caused by hot water (70-100 °C) from the water tank in traffic accidents. Overloading may have been one of the most important causes of the accidents. The burn wounds were located mostly (64.3%) in the buttocks and lower extremities (especially the thigh), and usually took 3-4 weeks for complete healing. Most of the patients presented a moderate burn area (20-50% TBSA) and deep partial-thickness or full-thickness burns. For the purpose of prevention of these injuries and improvement of patient prognosis, a number of recommendations are made.

Introduction

There are several reports in the literature regarding burns related to motorcycle and traffic accidents.[1-3] But hitherto no report has dealt with burns caused by motor farming tricycles. Most peasants in rural areas of China are not rich enough to buy themselves a car, and the motor farming tricycle is therefore a very popular means of transport for peasants owing to its low cost and ease of driving. However, apart from traffic accidents, we frequently encounter hot water burns caused by the water tank of these motor tricycles, especially during busy seasons such as early spring and late autumn. As most such burn cases occur in rural areas, there tend to be no reports and no investigations into the factors responsible for hot water burns caused by the water tank of motor farming tricycles, and this prompted us to perform a retrospective study of a series of cases.

Materials and methods

One hundred and twenty-six patients with burns caused by the water tank of motor farming tricycles (*Fig. 1*) were admitted to the 477th PLA military hospital in Hubei Province, China, over the 10-year period from December 1989 to December 1999. The clinical notes of 126 patients were available for review and only these patients were included in the study. The water tank is a reservoir for engine coolant. The data analysis from the case notes included sex, age, marital status, socio-economic condition, injury mechanism, time of injury, distribution and extent of burn, treatment, mortality, and prognosis. Our study does not include burns caused by friction injury related to motor farming tricycle accidents. All data were entered into a computer database and analysed.

Fig. 1 - Site of water tank under seat. The tank is the reservoir for engine coolant.

Results

The 126 patients were all burned by hot water from the water tank of motor farming tricycles following accidents. Of these patients, 116 were drivers of the tricycles and the remaining ten patients were

injured as passengers or bystanders. All the patients were Chinese peasants in rural areas and most of them were not rich. The temperature of the hot water in the water tank of moving motor tricycles ranges from 70 to 100 °C (mean temperature, 81 ± 12 °C).

Table I - Distribution of patients by age and sex

	Age (yr)				Total
	< 20	20-30	30-40	> 40	
Male	38	43	27	5	113
Female	2	5	4	2	13
Total	40	48	31	7	126

Sex, age, and marital status

Of the 126 patients, 113 were male (89.7%) and 13 female (10.3%). Of the females, four were drivers

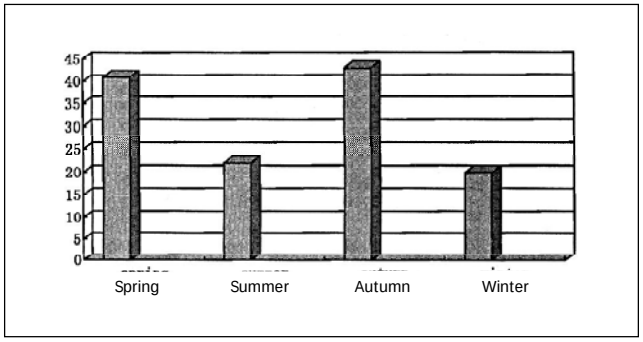

Fig. 2 - Seasonal distribution of burns.

and the other nine were injured as passengers or bystanders. The average age of the patients was 25.4 yr (range, 18-45) (*Table 1*). Seventy-five patients (59.5%) were unmarried and 51 (40.5%) were married.

Incidence by season and injury mechanism

A seasonal variation was observed, with the majority of cases (84 patients, 66.7%) occurring during spring and autumn (*Fig. 2*), which are the peasants' busiest seasons. The majority of cases (116 patients) were related to traffic accidents, and 93 traffic accidents occurred in rural areas with bad road conditions. Twenty-three patients were burned during the rush hour in cities. Most of the traffic accidents occurred as a result of overloading the tricycle.

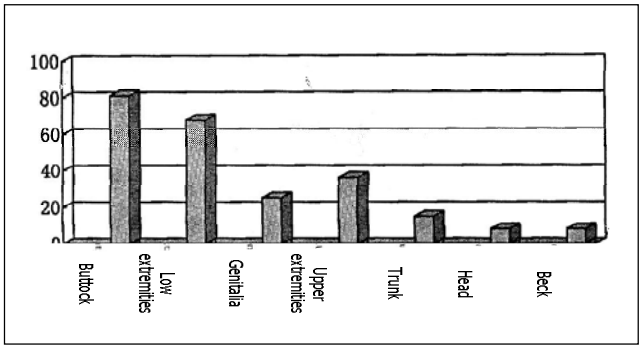

Fig. 3 - Seasonal distribution of burns.

Body area burned, percentage of total body surface area, and full-thickness burns

Eighty-one patients (64.3%) had burn wounds in

Table II - Distribution of TBSA burned

TBSA (percentage)	< 10	10-20	20-30	30-40	40-50	> 50
Number of patients	19	41	32	18	11	5

Table III - Distribution of full-thickness burn wounds

Full-thickness burn wounds (percentage)	< 5	5-10	10-20	30-40	> 40
Number of patients	56	43	15	10	2

the buttocks and lower extremities (especially the thigh) and 25 patients (19.8%) had burn wounds over the external genitalia area. Among all the patients, 36 sustained burns in both upper extremities simultaneously, 15 in the trunk, and eight in the head and neck (*Fig. 3*). The percentage of total body surface area (TBSA) burns ranged from 5 to 56% TBSA (mean, 20.6 ± 12.3%). Only five patients (4.0%) sustained burns greater than 50% TBSA. One hundred and two patients (81.0%) sustained deep partial-thickness burns and 68 (54.0%) had full-thickness burns wounds. The mean percentage of full-thickness burns was 11.3 ± 8.6% TBSA (range, 0-43%) (*Tables II, III*).

Admission time, treatment, and length of hospital stay

Ninety-eight patients (77.8%) were admitted in the immediate post-burn period and the remaining 28 patients (22.2%) were admitted after a period of treatment in local hospitals. The average time interval between the burn injury and admission was 5.2 ± 4.3 h (range, 0.5 to 15 h). Sixty-six patients (52.4%) received tangential excision or escharectomy and early skin autograft, while the remaining 36 patients (28.6%) with deep partial-thickness or full-thickness burn wounds received a delayed procedure because they did not agree to undergo an operation. The mean duration of hospital stay was 42 days (range, 7 to 73 days). More than 56% of the patients stayed for less than four weeks. Sixteen patients stayed for more than two months.

Mortality and prognosis

Three patients (two male and one female, i.e. 2.4%) died of burn wound sepsis. One hundred and twenty-three patients recovered completely and were discharged. Sixty-seven patients developed blisters in the healed burn wounds and 96 developed mild itching over healed areas. From the viewpoint of cosmetology, 106 patients (84.1%) declared themselves to be unsatisfied with the appearance of their burn scars, pigmentation, or other abnormalities such as hypertrophic scars. Five patients (4.0%) had post-burn contractures in the knee joint.

Discussion

Motor-vehicle-related burns have been frequently reported. Purdue et al.[1] and Papaevangelou et al.[2] found respectively that motorcycles accounted for 9.0% and 6.5% of burns arising from motor vehicle accidents. But burns related to motor farming tricycle accidents have not been reported in previous articles. In western countries, because of better safety measures and the comparative rarity of motor farming tricycles, burns caused by such vehicles have rarely been reported. But in China, as a result of the low price and the ease of learning to drive this vehicle, many Chinese peasants in rural areas use such tricycles for transportation. Consequently, because of the relatively high density of such tricycles in Chinese rural areas and also because of bad road conditions, the incidence of farming-tricycle-related burns is much higher in rural areas than in the cities of China. Such burns, resulting from hot water in the water tank, differ from other hot water burns in everyday life. Our study highlights some of the characteristic features of these injuries, which occurred in 126 patients owing to hot water from the water tank of motor farming tricycles involved in traffic accidents. The patients were treated in our hospital over the ten-year period from December 1989 to December 1999.

The population of the study demonstrated distinct demographic characteristics. In our study, the persons at greatest risk were young male peasants in the 18- to 40-yr-old age group. Young males were more burned frequently than females (approaching a ratio of 9:1), a figure that differs from other studies[3] which reported that the majority of patients (75.7%) with contact burns caused by motorcycle exhaust pipes were unmarried young females wearing short pants or miniskirts. We found a definite young male predominance. This is not surprising, in the Chinese countryside, as young male peasants constitute the majority of drivers. Females and young persons less than 18 years old would not be allowed to drive by other family members for reasons of safety, and they sustained their injuries as passengers or bystanders. Most of the patients were the tricycle drivers themselves (116 patients, i.e. 92.1%). Of these 116 patients, only four were female drivers.

The water tank of such motor farming tricycles is located just beneath the driver's seat, and the water temperature in a moving tricycle ranges from 70 to 100 °C, depending on the speed, time of day, and type of tricycle. When traffic accidents occur, the tricycles easily turn over, owing to the vehicle's unsteady equilibrium, and hot water is splashed out of the tank. Frequently the drivers are trapped under the tricycle, unable to get free, resulting in protracted contact with hot water which causes deep partial-thickness or full-thickness burn wounds. In our study, the length of contact with hot water ranged from 5 sec to 5 h (mean, 5 ± 3 min). A previous study showed that there is a time-temperature relationship with the depth of the burn wound.[4] Knabl et al.[5] reported that a round aluminium stamp with a contact area of 4 cm^2 and weighing 85 g was heated to 80 °C and applied for 14 sec without additional pressure to the depilated dorsal skin of rabbits. This procedure produced a partial-thickness skin burn injury. A study conducted by Feng Shijie et al.[6] showed that exposure for 15 sec to a 70 °C, 80 °C, and 95 °C water bath produced respectively superficial partial-thickness burns, deep partial-thickness burns, and full-thickness burns (confirmed by histopathology). It is easy to understand how most of our patients (102 patients, i.e. 81.0%) sustained deep partial-thickness burns and 68 (54.0%) had full-thickness burns wounds.

As might be expected in such burns, the lesions were predominantly located in the buttocks and lower extremities (81 cases, 64.3%) and the external genitalia (25 cases, 20.0%). This clearly the reflects the design of the motor farming tricycle, as the buttocks and lower extremities (especially the thigh) are

in close proximity to the water tank (volume, 5 l), making them especially vulnerable. The tricycle design may also have an effect on the extent and severity of the injury. The percentage of TBSA burned ranged from 5 to 56% (mean, 20.6 ± 12.3%) and the mean percentage of full-thickness burns was 11.3 ± 8.6% (range, 0-43%).

The highest incidence of burns was during the busy seasons of early spring and late autumn (84 patients, 66.7%) in rural areas. This high incidence can be attributed firstly to the much higher utilization rate of motor farming tricycles in spring and autumn than in other seasons and secondly to the general conditions of traffic in spring and autumn, which is much busier in the countryside in China than in summer and winter.

Sixty-six patients (52.4%) received tangential excision or escharectomy and early skin autograft, and the 36 patients with deep partial- or full-thickness burns received a delayed procedure because they were unwilling to undergo surgery. The mean duration of hospital stay was 42 days (range, 7 to 73 days). All the patients were poor peasants uninsured against injury. This sort of lesion can have obvious financial implications for both patient and family as it can lead to a significant period of hospitalization. However, many patients with deep burn wounds did not receive surgery owing to traditional Chinese concepts and to psychological fear of an operation - all the patients had little medical knowledge. This resulted in a longer period of hospitalization, severe burn scars, a worse prognosis, and two deaths (caused by burn wound sepsis).

Conclusion

Our study reveals some interesting factors related to burns caused by the water tank of motor farming tricycles, including the mechanism of injuries, the victims' socio-economic status, and the site of the burn wounds. Because of the popularity of motor farming tricycles in rural areas of China, it is estimated that several thousand burns occur every year. For the purpose of preventing such injuries and improving patient prognosis, we make the following recommendations:

1. The design of the motor farming tricycle should be changed. Separation of the water tank from the seat is the most obvious way to reduce the frequency of such burns. Also, more attention should be paid to the equilibrium of the vehicle, especially when it is moving.
2. Road conditions should be improved as this will reduce traffic accidents.
2. Traffic security should be increased, especially in rural areas. Overloading should be strictly forbidden.
4. Insurance against injury and necessary medical knowledge should be ensured for these peasants.

RESUME. Les brûlures causées par les tanks à eau des tricycles motorisés agricoles n'ont pas été décrites dans la littérature. Les Auteurs ont effectué une étude rétrospective de ce type de brûlure dans 126 patients complètement documentés qui provenaient des zones rurales de la Chine. La plupart des patients étaient célibataires (59,5%), jeunes (55,6% entre 20 et 40 ans) et mâles (rapport mâles-femelles, 9:1). Les brûlures se sont vérifiées surtout (66,7% des cas) pendant les saisons de majeure activité, c'est-à-dire le printemps et l'été. La cause principale des brûlures était l'eau chaude (70-100 °C) provenant du tank à eau d'un tricycle motorisé à la suite d'un accident de la route. La surcharge est peut-être la cause la plus importante des accidents. Les brûlures étaient localisées principalement (64.3%) dans les fesses et les extrémités inférieures (particulièrement les cuisses), et il fallait attendre 3-4 semaines avant la guérison complète. La plupart des patients présentaient une surface brûlée d'extension moyenne (20-50% de la surface corporelle totale) et des brûlures profondes d'épaisseur variable ou d'épaisseur totale. Les Auteurs présentent une série de recommandations pour prévenir ce type de lésion et améliorer le pronostic des patients.

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