

# The Impact of Mandatory Helmet Law on the Outcome of Maxillo Facial Trauma: A Comparative Study in Kerala

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## Abstract

**Introduction** Motorcyclists comprise the majority of road-traffic victims in low and middle income countries, and consequently, the majority of the road-traffic victims globally. Simple measures can be taken to make safer on the roads, which include enforcement of safety measures like seat belt and helmets. The compulsory Helmet law was enforced in Kerala on 18/06/07. Resistance to legislation on motorcycle helmets still coexists world wide with debate on the effectiveness of helmets. In an attempt to analyze the protective effect of helmets on facial injuries a comparative study was conducted in Government Dental College, Calicut, which is a major trauma centre in northern Kerala.

**Methods** Data for the present study was obtained from the patients who have reported to the Emergency Department of Oral and Maxillofacial Surgery, Government Dental College, Calicut, for a period of 6 months immediately after the implementation of strict helmet rule in Kerala. For the study all patients with a history of nonfatal motor cycle accident sustaining facial injuries were included. The

results were compared with the study conducted in the same institution in the pre law period.

**Results** The study demonstrates the protective effect of motorcycle helmets in decreasing the morbidity of maxillofacial trauma. There was a marked decrease in incidence of motorcycle-related injuries, remarkable increase in helmet usage and better outcome in helmeted individuals in the post law period.

**Conclusion** Road traffic injury control is a public health problem. Health and medical professionals have an ethical responsibility to educate and arrange for the safety of individuals. Helmets are effective in preventing or reducing the severity of motorcycle-related injuries and in a developing country like India, enforced mandatory motor cycle helmet law is potentially one of the most cost effective interventions available.

**Keywords** Motor cycle trauma · Helmet law · Kerala · Maxillofacial injuries

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## Introduction

Road traffic accidents are on an alarming increase every year and can be considered as a man-made epidemic which affects mainly the young and productive generations of the world. Motorcyclists and pedestrians comprise the majority of road-traffic victims in low and middle-income countries, and consequently, the majority of the road-traffic victims globally [1]. In 2005, road traffic injuries resulted in the death of an estimated 110,000 persons, 2.5 million hospitalizations, 8–9 million minor injuries and economic losses to the tune of 3 % of the gross domestic product in India [2]. Of all the injuries, facial injuries have been repeatedly shown to be associated with motor cycle accidents. Face is

often the seat of recognition for a human being and living with a change in the appearance of one's face as a result of injury is always a challenging task. The victim may encounter with many psychosocial problems like unemployment, lower education level and poor social support leading to post-traumatic stress disorder [3].

Most of the factors responsible for road traffic accidents and its consequences are preventable. Simple measures can be taken to make travel safer on the roads, which include enforcement of safety measures like seat belt and helmets. Helmets are effective in preventing or reducing the severity of motorcycle-related injuries [4–8] and in a developing country like India, enforced mandatory motor cycle helmet laws are potentially one of the most cost effective interventions available.

Although there is a sizable body of reports by many authors from all over the world, that the mandatory use of helmets shows a major decrease in morbidity of serious injuries and mortality of the victims, medical documentation of these have not been adequately presented to the public. Resistance to legislation on motorcycle helmets still coexists with debate on the effectiveness of helmets and the motorcyclists advocacy groups have been successful at repealing state helmet laws in different nations. The opposition could be mainly due to lack of initiative and ignorance of the serious consequences and absence of reliable and quality information on better road safety measures.

Appropriately responding to the disparities in available evidence and prevention efforts is necessary if we are to comprehensively address this global-health dilemma [1]. There are not many population-based data on maxillofacial injuries and its prevention in our country and there is large heterogeneity in the published data. No relevant studies have been done so far in Kerala to assess and compare the incidence and characteristics of facial injury pattern as seen in helmeted and non-helmeted motor cycle accident victims. The compulsory helmet law was enforced in the state on 18/06/07 as per the high court verdict. In an attempt to analyze the protective effect of helmets on facial injuries a comparative study was conducted in Government Dental College, Calicut, which is a major trauma centre in northern Kerala.

### Aims & Objectives

- To assess the protective effect of helmets in decreasing maxillofacial injuries
- To compare the pattern and demographic distribution of maxillofacial fractures and injuries between helmeted and nonhelmeted individuals and with the type of helmets if possible, thereby assessing the degree of protection offered by helmets.

### Materials & Methods

Data for the present study was obtained from the patients who reported to the Emergency Department of Oral and Maxillofacial Surgery, Government Dental College, Calicut, for a period of 6 months immediately after the implementation of strict helmet rule in Kerala on 18/06/2007. For this study we included all patients with a history of nonfatal motor cycle accidents who sustained facial injuries regardless of the presence of injuries to other areas of the body. A proforma was prepared for this comparative study. The personal data, detailed description of the incidence, clinical signs and symptoms were recorded. Special mention regarding the patient being the driver or pillion rider and helmet wearer or not and the location of the accident as urban or rural area was made. The seriousness of the injuries were graded from superficial injuries of face and teeth, to severe fractures of maxillofacial skeleton. Distribution of pattern of facial fractures and injuries of separate bones were recorded. The pattern of injury to the soft tissue, teeth and facial bones were also compared between helmeted and nonhelmeted individuals.

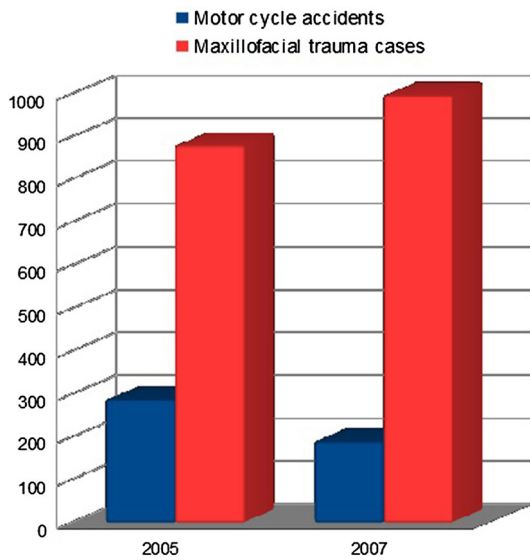
If a helmet was worn, information was collected regarding the type of helmet. The diagnosis was based on clinical and radiological findings. In relevant cases CT scan was also taken.

A study on the meta-analysis of maxillofacial trauma cases in northern Kerala was done in our institution in 2005 [9]. Cases of motor cycle accidents were selected separately from the above and compared with the results of our study in the post helmet law period of 2007.

The data obtained were computerized and analyzed with SPSS software.

### Results

During the study period, 998 cases of maxillofacial trauma were reported in the Emergency Department of Govt Dental College, Calicut after the implementation of strict helmet rule in the state. During the previous study 881 patients reported with maxillofacial trauma from June to December 2005 [9]; so there is a 13 % increase in incidence from 2005 to 2007. The total number of motor cycle accident cases reported in the present study was 191 and that in the prehelmet law period was 289 (34 % decrease in incidence of motor cycle accidents from the prelaw to postlaw period). The incidence of maxillofacial trauma cases and motorcyclists sustaining facial injuries in both the studies were compared statistically and the values  $Z = 6.84$  and  $P < 0.001$  was found to be statistically very significant. Figure 1 shows a comparison of cases in prehelmet and posthelmet periods.



**Fig. 1** Incidence of cases in the pre & post helmet law period

**Age & Sex**

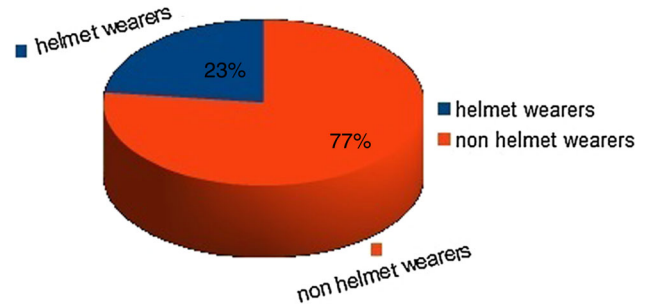
In the present study, the patients’ age ranged from 14 to 80 years. The mean age was 28.31 with a standard deviation of 9.75. Highest numbers of patients were in the 21–30 year age group (100 patients). The age of male patients ranged from 14 to 80 years (mean age 47 years) and that of female patients from 15 to 46 years (mean age 31.5 years). The overall male to female ratio was 9:1. The age wise and sex wise distribution of motor cycle trauma cases is shown in Table 1.

**Helmet Usage**

Of the total number of 191 patients, only 43 patients reported wearing a helmet during the accident (23 %). Of these only 3 patients were females. No information was gained regarding wearing of helmet from 4 patients in this study. During the prelaw period in 2005, only 2 patients had reported to the casualty wearing a helmet during the accident. The proportion of helmet wearers in the postlaw

**Table 1** Age and sex wise distribution of cases

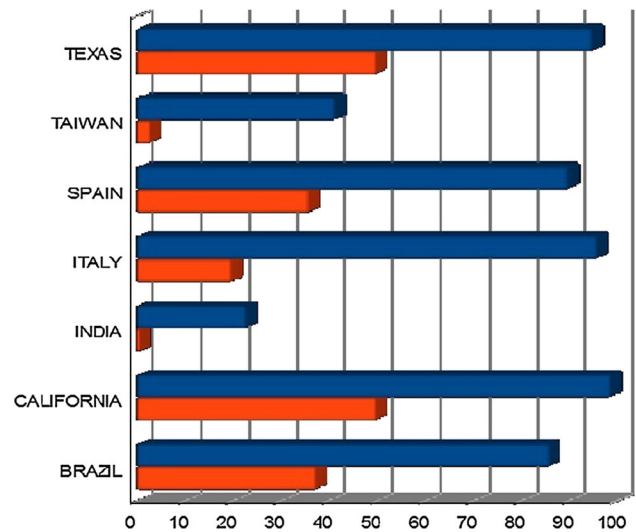
Age	Male	Female	Total
10–20	31	4	35
21–30	95	5	100
31–40	31	5	36
41–50	9	3	12
51–60	7	0	7
61–70	0	0	0
71–80	1	0	1
Total	174	17	191



**Fig. 2** Helmet wearers in the post law period

**Table 2** Pre & postlaw helmet usage in different countries

Country	Helmet usage–prelaw (%)	Postlaw (%)
California	50.00	99.00
Italy	20.00	96.00
Texas	50.00	95.00
Spain	36.00	90.00
Brazil	37.50	86.10
Taiwan	2.90	42.00
India	0.70	23.00



**Fig. 3** Helmet wearers in the pre and post law period in different countries

is shown in Fig. 2 The helmet use in the pre and postlaw periods in various countries is compared in Table 2 and Fig. 3.

**Distribution in Rural and Urban Areas**

Of the total motor cycle accidents reported during the 6 months study, 107 (57.5 %) occurred in the rural area and the

rest 79 (41.5 %) were within the city limits. The patients were also divided into drivers and pillion riders. The drivers were more involved in motor cycle accidents, accounting for 119 cases of the total (62.3 %). In the rest i.e. in 67 cases (35.1 %), pillion riders were the victims. The information regarding 5 patients was unavailable. Figure 4 shows the distribution of drivers and riders in rural and urban areas.

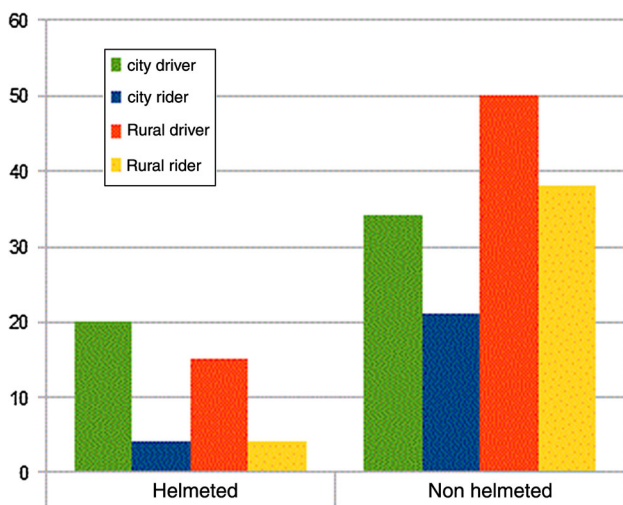
**Maxillofacial Injuries**

*Soft Tissue Injuries*

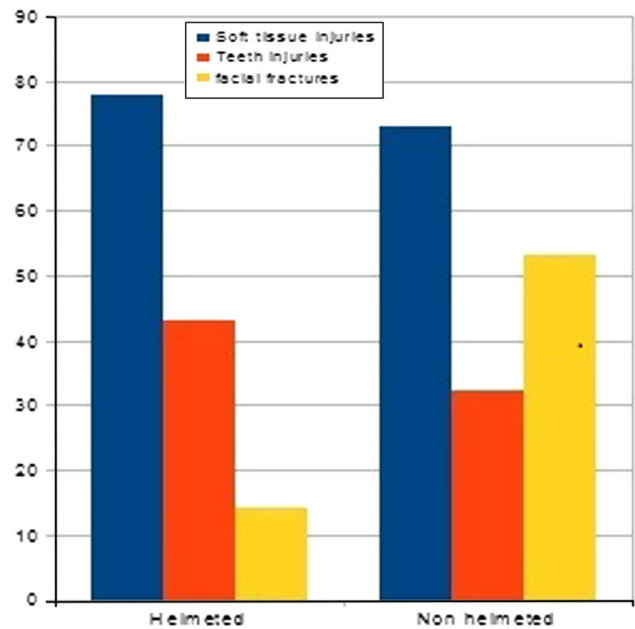
The soft tissue injuries sustained were recorded and graded as lacerations and abrasions. Of the patients included in the study, 131 patients (70.1 %) reported with soft tissue injuries. Of these, 97 patients (74 %) were nonhelmet wearing individuals. In the helmet wearing group 34 patients reported with soft tissue injuries which forms about 79.1 % of the total helmet wearing patients in the study. The Chi square value was  $\chi^2 = 2.164$  and  $P = 0.098$  is not statistically significant.

*Teeth Injuries*

The injuries to the teeth of the patients involved in motor cycle accidents during the study period were graded as fractured, mobile, and avulsed. The total number of teeth involved in each category was also noted. Seventy-one patients (38.4 %) had teeth injuries, of whom 58 patients were from the nonhelmeted group and 13 were from the helmeted group. The Chi square value was  $\chi^2 = 1.572$  and  $P$  value = 1.41. We also compared the incidences of teeth injuries in the previous study conducted in 2005–2006. It was found that 122 (42 %) patients had teeth injuries.



**Fig. 4** Area wise distribution of divers & riders



**Fig. 5** Injuries in helmeted and nonhelmeted individuals

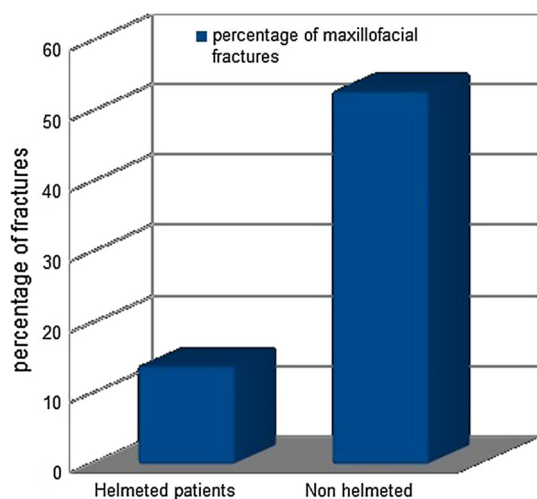
Figure 5 shows a comparison of injuries between helmeted and unhelmeted patients.

*Fractures of the Maxillofacial Skeleton*

For the purpose of the study, fractures of the middle third and lower third of the face were taken into consideration. In the lower third, the mandible was divided into dentoalveolar, body, symphysis, parasymphysis, angle, condyle, subcondyle and coronoid regions. In the middle third of the face, fractures were recorded as dentoalveolar, Le Fort I, II and III types, zygomatic, nasal or palatine bones.

In the study group, 85 patients (44.5 %) sustained facial bone fractures. Of them 79 were from nonhelmeted group and 6 were wearing helmets. In Fig. 6 the incidence of facial fractures between helmeted and nonhelmeted individuals are compared, which is 14 % and 53 % respectively. When the facial fractures are compared the Chi square value is 21.930 and  $P$  value is 0.000, which is highly significant and shows that helmets do give good protection in preventing fractures of the maxillofacial skeleton. It gives almost four times more protection against the fractures of facial skeleton. During the previous study 109 patients out of 289 (38 %) had fractures of the maxillofacial skeleton [9]. It is very evident from our study that morbidity following road traffic accidents is increasing every year, which has increased from 38 to 44.5 % from 2005 to 2007 even though the helmet wearing group had a lesser percentage of fractures.

The facial fractures sustained by helmeted individuals were studied. Only 6 patients (14 %) sustained fractures of facial bones. Two had maxilla fracture, of which one had



**Fig. 6** Percentage of maxillofacial fractures in helmeted & nonhelmeted patients

dentoalveolar fracture also. Two patients had zygomatic fractures. One patient had unilateral zygomatic fracture with Le Fort I maxilla fracture and one patient sustained undisplaced fracture of the mandible.

Among the helmeted individuals two patients reported wearing full face helmets, and they sustained only very minor injuries i.e. abrasions alone. Teeth injuries and facial fractures were absent in these individuals. In 2005 only two patients reported wearing helmets and they did not sustain any fractures of the facial skeleton.

## Discussion

Our study shows very positive results on the outcome of maxillofacial injuries after the implementation of strict helmet law, as there is a reduction in motor cycle accidents by 34 %, increase in helmet usage by more than 32 % and the reduction in the incidence of facial fractures in helmeted individuals (14 %) compared to (53 %) in nonhelmeted patients in the post law period (Figs. 1, 3, 6).

The incidence of road traffic accidents were higher in males and in second to third decades of life, which is similar to most of the studies by various authors [6, 9–13]. This can be also explained by the fact that during this age, people, especially males, are more mobile, go out for work and take risks.

There was a 34 % decrease in the incidence of motor cycle accidents in the postlaw period (from 2005 to 2007) The incidence of trauma cases of the facial region and motor cyclists sustaining facial injuries in both the studies were compared statistically and the values  $Z = 6.84$  and  $P < 0.001$  was found to be statistically very significant (Fig. 1).

Our results are comparable with those from Thailand, where there was a 33.5 % decrease in incidence [14].

Although helmet use is probably responsible for this decrease, other factors may also have contributed. The law change may have affected the risk behavior of drivers or reduced the number of motorcycle sales, high risk riders, or miles driven [15, 16]. In India the recent hike in socio economic status has resulted in fast growth in the volume of road traffic. Bad roads, speeding and rash driving may be contributing to the increasing incidence of road traffic accidents every year.

The total number of cases reported in comparison with a study conducted by Nair and Paul [17] in Trivandrum, Kerala about 20 years back, shows that there is almost a three times increase in maxillofacial trauma cases. Our study is really an eye opener for the increased incidence of road traffic accidents in geometric proportions. In a recent study conducted at Malaysia, the incidence of motorcycle accidents in a major referral hospital was only 113 cases in a period of 2 years, where as the figures are more than fourfold in our centre [13]. There were more instances of accidents in rural areas probably because of poor maintenance of roads and less awareness of public regarding safety measures. Figure 4 shows the distribution of patients in rural and urban areas.

## Helmet Usage

Helmet usage has increased considerably (>32 %) after the implementation of the strict helmet law in Kerala. We tried to get information regarding the mandatory helmet rule implemented in different parts of the world. In California the helmet usage increased from 50 to 99 % in the postlaw period [7]. In Maryland there was repeal of helmet law and consequently the helmet usage dropped from about 100 % to 50–66 % 2 years later [16]. In Italy the helmet usage rose from 20 to 96 % after the implementation of the strict helmet law [8]. In Taiwan the values were 2.9 and 41.6 % respectively [18]. In Texas, survey was done in 18 cities providing a cross-section of urban and suburban traffic of the state and an increase was seen in helmet use from less than 50 % just before the law to 90 % immediately after and to more than 95 % 2 months later. In a study conducted at Illinois only 14.6 % were helmeted of the total 398 patients [19]. In Brazil non-use of helmet has decreased from 62.5 to 13.9 % from 1997 to 2000 after implementation of law in 1998. Hyder et al. [14] reports that helmet usage increased fivefold in Thailand after the compulsory helmet rule. In a study at Miami, after the repeal of the helmet law the helmet usage decreased from 83 % in 1999 to 56 % after one year [20]. The NHTSA GES database yielded 5,328 sample patients of whom 34.8 % were unhelmeted and 65.2 % were helmeted [21]. Our values are very much consistent with a study by Johnson [6] who studied 331 patients of whom 23 % were

helmeted. In a recent study conducted at Bangalore, India 63.5 % of the two-wheeler users did not use helmets. The helmet usage of about 37 % shows better usage of helmets in a city and there is more compliance to rules in Bangalore than in our state [22]. Even though the helmet law was implemented in various states in our country not much data was obtained regarding its outcome.

The helmet use in the postlaw period in our state is even less than the usage in the prelaw periods in developed countries like the United States. More strict laws in the rural areas can also increase the number of helmet wearers in the state.

### Maxillofacial Injuries

The instances of facial fractures between helmeted and nonhelmeted individuals is 14 % and 53 % respectively. When the fractures are compared the Chi square value is 21.930 and *P* value is 0.000, which is highly significant. So our study does establish that helmets give good protection in preventing fractures of the maxillofacial skeleton. It gives almost four times more protection against the fractures of facial skeleton.

The incidence of craniofacial trauma can be greatly reduced by improvement in automotive safety devices and compliance by motor vehicle occupants, and utilization of helmets [23].

In a study by Gopalakrishna et al in USA [4] on facial injuries involving both helmeted and nonhelmeted motorcyclists, nearly a quarter (24.3 %) of motorcyclists involved in crashes sustained some form of facial injury and 36.8 % of helmeted riders sustained facial injuries compared to 53.8 % of nonhelmeted riders.

Bachulis et al. [24] also reported that approximately a quarter of all motorcyclists involved in crashes suffered from some form of maxillofacial injury, with approximately twice as many nonhelmeted riders having facial fractures (12.8 %) than helmeted riders (6.8 %).

In a study from Scotland [36] only 9 % of helmeted motorcycle riders sustained maxillofacial trauma. Vaughan et al [25] indicated that the incidence of facial fractures was relatively low when wearing a helmet and the most protection was offered by the full face design. Johnson [6] also documented that nonhelmeted motorcyclists are over three times as likely to suffer from facial fractures (16.1 %) versus 5.2 % in helmeted riders. Cannell et al [26] also showed similar results. The nonhelmeted patients had higher Injury Severity Scores (11.9 vs 7.02). Heilman et al. [5] found that compared to their helmeted counterparts, helmetless riders suffered 2–3 times more head, neck and facial trauma. In almost all the above mentioned studies the incidence of maxillofacial trauma was around or less than 10 % in helmeted individuals. Compared to this our value

of 14 % is high and probably accounts for other risk factors like speed, condition of road and low quality of helmets used. In our study two patients reported wearing full face helmets and they did not sustain any fractures of the facial skeleton.

Vaughan et al. [25] in their study, about 35 years ago, had suggested that the use of full face helmets should be encouraged and consideration given to the revision of helmet standards to require the provision of facial protection.

The proven benefits from all these studies conducted worldwide on helmet use in bicyclists and motorcyclists almost for half a century make a compelling argument for advocating its use. Efficient legislation with adequate surveillance of infringing behaviors is essential to increase the number of road users who use safety equipment. This should highlight the socioeconomic and other problems of road traffic accidents and the role of individuals in its prevention.

‘Alcohol—the killer on road’ is a well documented fact [27, 28]. The association of alcohol consumption is related to free availability and nonrestriction on sale. The Government should have some strong legal enforcement against alcohol usage [27].

The reason for the different rates of trauma due to road traffic accidents in developed countries could be because of use of seatbelts, construction of roads and subways and more effective traffic discipline [29].

Mandatory use of helmet for bicycle riders will also help to reduce the maxillofacial injuries and morbidity related to it at a younger age.

The bad conditions of our roads probably contribute for the large number of accident cases, as many of the patients report that they were thrown away after riding onto a gutter in the road, which is often overlooked by the driver.

### Helmet Usage and Controversies

There are many misconceptions among the public regarding helmet usage that it increases associated injuries to other parts of the body. Various studies prove that there was no association between helmet use and the occurrence of neck or cervical spine injuries [30, 31]. Yates and Dickenson illustrate the potential for further development in helmet design and safety to reduce the incidence of significant facial injuries including soft tissue damage and facial fractures in motorcyclists involved in low speed accidents [32]. An instance of injury to the neck causing laryngeal injury by the twisting of the face guard of a helmet in a case has been reported by Kim et al [33]. Further research into the mechanism and incidence of neck injury in different types of helmets may be warranted as it may lead to changes in the specifications of jaw guards [33].

## Limitations of Our Study

The precise magnitude of the protective effect of helmets could not be estimated, since it was not possible to completely disentangle protective effects against facial injury from the effects of head injury occurring concurrently in the same individual. Another limitation of this study is the unmeasured factors not taken into consideration which may have placed the patient at lesser risk for the accident. Even though the casualty of Oral and Maxillofacial Surgery Department is a major referral centre in northern Kerala, the cases being attended in other centres were not included in the study. So our study does not give the true representation as accurately as in a multicentric study.

## Conclusion

We, as a surgical community have an ethical responsibility to work for the safety of patients and every effort should be taken for it. The results of our study are consistent in suggesting a protective effect of motor cycle helmets on serious injuries of the facial region. More than any vaccine and any community clinic a very simple preventive measure i.e. the helmet on the head saves tens to thousands of young lives every year. We have to accept that road traffic injury control is a public health problem and there is an ethical responsibility to arrange for the safety of individuals. Health and medical professionals have to assume responsibility for participating in efforts to control this pandemic [34]. This raises questions about the possibilities for articulating an ethics of public health that would call upon government to protect citizens from their own choices that results in needless morbidity and suffering [25].

There are many nonprofit organizations dedicated to educate the public and provide road traffic safety resources to developing countries. With their help we can conduct public awareness campaigns, encourage passenger helmet use on television, radio, etc., complemented by helmet donations and traffic safety education for students and teachers at high-risk schools and a revision of traffic regulations to expand mandatory helmet use to adult and child passengers. We strongly believe that it will definitely improve the current scenario. Immediate steps are required to curb this problem to limit the loss of life and resources [35].

We hope that the information provided here will be useful to the medical community who need to educate their state lawmakers on the importance of this type of legislation.

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