Original Article - Retrospective Study

# Maxillofacial Injuries in Motorcyclists Following the Implementation of Helmet

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## Abstract

**Background:** It has been reported that 20%–60% of all people injured in road traffic accidents (RTAs) tend to have some form of maxillofacial injury. Mangalore city, Karnataka State, India, traffic police has enforced the law to wear helmets to tackle the problem. The outcome of the initiative till date was not measured. Therefore, the objective of the study was to assess the prevalence of maxillofacial injuries among the victims of motorized two-wheeler RTAs, following the passing of the helmet law. **Materials and Methods:** The study was conducted at the Accident and Emergency Department of K.S. Hegde Medical College and Hospital and at the Department of Oral and Maxillofacial Surgery, A.B. Shetty Memorial Institute of Dental Sciences, Nitte (Deemed to be University), Mangalore, Karnataka, India. The inclusion criteria were the patients who had two-wheeler accidents during the time period of 2016–2017 was collected. The data related to age, gender, helmet wearing, diagnosis, and type of orthopedic injuries was included. A descriptive statistics was calculated along with 95% confidence interval; correlation coefficient and odds ratio using STATA software. **Results:** A total of $N = 347$ individuals were included in the study. The mean age of the individuals was 33.7 (2–85) years, and the median age was 32 years. 81.55% ($N = 283$) were male and 18.44% ($N = 64$) were female. Among the individuals, 51.5% ($N = 179$) were not wearing helmets and 44.38% ($N = 154$) of them were males. A total of 25.07 ($N = 87$) individuals had orthopedic injuries and 16.42% ($N = 57$) individuals had orthopedic injuries who were not wearing helmets. **Conclusion:** Under the limitations of the study, we conclude that majority of the two-wheelers are not wearing helmets. This study has demonstrated that the impact of wearing helmet on occurrence of craniofacial and orthopedic injuries is less.

**Keywords:** Craniofacial, helmet, injury, motorbike, orthopedics, road safety, trauma

## Introduction

India is one of the most rapidly developing third world countries both on the front of economic and demographic transition.[1] This boon, however, has come with a serious drawback of increasing urbanization and motorization.[2] In a study done by Jagnoor *et al*. (2015) on the prevention of road traffic accidents (RTAs), it was noted that over 1.2 million people are seriously injured, 300,000 permanently disabled, and 80,000 die in traffic accidents annually in India.[3]

According to the data from the National Crime Records Bureau, the deaths and injuries related to RTAs has increased two and four folds during the period of 1991–2005.[4] Motorized two-wheelers are the main component of Indian road traffic and are also the most vulnerable group for RTAs.[5] Road use patterns in India differ considerably from other countries. Lane segregation is not done for bicycles, motorized two-wheelers, or four-wheelers.[6] The riders of two-wheelers seem to have maximum case fatality in accidents. Two-wheeler users are directly exposed to and tend to come in contact with the impacting vehicle or the obstacle during a collision, resulting in severe injuries and fatalities.[7]

Mangalore has been developing exponentially from the past decade owing to rapid industrialization and being a center for educational growth.[8] Due to these highly rewarding educational as well as professional opportunities, it has

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been attracting a lot of talent from all over the country. As majority of these people are young, the use of two-wheelers has also increased a lot. As a result, the number of accidents has also increased as these individuals have not been strictly following the road safety laws, the most basic being wearing a helmet.[9-11]

It has been reported that 20%–60% of all people injured in RTAs tend to have some form of maxillofacial injury.[12-15] The chances of these injuries increase even more when helmets are not used routinely; these injuries are not only traumatic but also cause significant problems physiologically, functionally, and esthetically. The head-and-the neck region is the most exposed part of the body, making it a point of direct injury in RTAs.[16-26]

According to the previous study by Menon *et al*. (2008) there was a marked male preponderance (84.6%).[27] The most vulnerable age group was found to be between 21 and 30 years. Two-wheeler occupants were most commonly involved. Skull fractures were present in 88.88% of the cases. Fractures of the vault were found in 88%, base of the skull in 35.97%, and a combination of both in 35% of the cases. In most of the cases, fissured fractures were found (23%). Among intracranial hemorrhages, subdural hemorrhage was found in 52.63% and subarachnoid hemorrhage in 27.27% of the cases. Contusions and lacerations of the brain were found equally in 35% of the cases.[27]

Another study by Jain *et al*. (2009) aimed to determine the trend of two-wheeler accidents over the 5 years (2000–2004) with respect to age and sex of the victim, type of injury sustained, type of vehicle involved, and time distribution of accidents.[28] A total of 1231 two-wheeler accidents were recorded during 2000–2004. Majority (77%) of the victims were in the age group of 18–44 years. Accident rate among males (83%) was higher than that among females (17%). Five percent of the victims ($N = 75$) succumbed to injuries, of whom 45 died on the spot. Geared vehicles (81%) were more commonly involved than those without gears. Highest number of accidents was seen during 6–10 p.m.[28]

The routine use of helmets both for the rider and the pillion passenger has been strongly advocated since ages. Still, it is not a practice routinely adopted by the Indian population. To enforce the same, several laws have been passed. The Supreme Court Committee on Road Safety directed the state to implement the law of wearing helmets both by the pillion passenger and the rider, irrespective of the horsepower of the vehicle. There is noncompliance of the same to invite a penalty of Rs. 1000. The earlier rule was applicable only for riders, but the new rule has made helmets mandatory for both the rider and pillion across the state.

Mangalore city traffic police has enforced the same since February 1, 2016. After passing the law, it was stipulated that the number of head-and-neck injuries should plunge; however, no survey was taken up to assess if any such reduction was seen. Hence, this study was conducted to assess the prevalence of maxillofacial injuries among the victims of motorized two-wheeler RTAs, following the passing of the helmet law.

## Materials and Methods

The study was conducted at the Accident and Emergency Department of K.S. Hegde Medical College and Hospital and at the Department of Oral and Maxillofacial Surgery, A.B. Shetty Memorial Institute of Dental Sciences, Nitte (Deemed to be University), Mangalore, Karnataka, India. The inclusion criteria were the patients who had two-wheeler accidents during the time period of 2016–2017. The data were collected in relation to age, gender, helmet wear, diagnosis of craniofacial injury, and type of orthopedic injuries (other than craniofacial injuries) occurred. A descriptive statistics was calculated along with 95% confidence interval; correlation coefficient and odds ratio was calculated using STATA software (STATACORP LLC, United States).

## Results

**Table 1: Demographics of the individuals**

| | *n* (%) | Mean±SD (SE) | Minimum | Maximum |
|---|---|---|---|---|
| Age | 347 | 33.70±14.34 (0.78) | 2 | 85 |
| Gender | | | | |
| Male | 283 (81.55) | - | - | - |
| Female | 64 (18.44) | - | - | - |
| Total | 347 (100.0) | - | - | - |

SD=Standard deviation; SE=Standard error

**Table 2: Correlation of helmet wearing among gender**

| | Helmet | | Total, *n* (%) |
|---|---|---|---|
| | Yes, *n* (%) | No, *n* (%) | |
| Male | 129 (37.2) | 154 (44.38) | 283 (81.55) |
| Female | 39 (11.2) | 25 (7.2) | 64 (18.44) |
| Total | 168 (48.5) | 179 (51.5) | 347 (100.0) |

**Table 3: Correlation of helmet wearing with craniofacial and orthopedic injuries among gender**

| | Orthopedic injuries | | Total, *n* (%) |
|---|---|---|---|
| | Yes, *n* (%) | No, *n* (%) | |
| Male | 74 (21.76) | 209 (59.4) | 283 (81.55) |
| Female | 13 (3.8) | 51 (1.5) | 64 (5.3) |
| Total | 87 (25.07) | 260 (74.92) | 347 (100.0) |

**Table 4: Association of Orthopaedic injuries and helmet**

| | Orthopaedic Injuries | | Total *n* (%) | *P*<0.001 |
|---|---|---|---|---|
| | Yes *n* (%) | No *n* (%) | | |
| Helmet | | | | |
| Yes | 30 (8.6) | 143 (41.21) | 173 (49.86) | 0.001 |
| No | 57 (16.42) | 117 (33.71) | 174 (50.15) | 0.001 |
| Total | 87 (25.07) | 260 (74.92) | 347 (100.0) | 0.001 |

**Table 5: Category of fracture occurred with or without helmet[30]**

| Category of craniofacial injuries | Total, *n* (%) | Helmet | |
|---|---|---|---|
| | | Yes, *n* (%) | No, *n* (%) |
| Type 1a: Soft-tissue injury <2 cm in length without bony fracture | 57 (16.42) | 41 (24.40) | 15 (8.3) |
| Type 1b: Soft-tissue injury >2 cm in length without bony fracture | 93 (26.80) | 61 (36.30) | 32 (17.87) |
| Type 1c: Multiple soft-tissue injuries without bony fracture | 68 (19.59) | 44 (26.19) | 24 (13.40) |
| Level 1 Aocmf: most elementary. It identifies no more than the presence of fractures in four separate anatomical units | | | |
| Code 91: Mandible | 48 (13.83) | 9 (5.3) | 39 (21.78) |
| Code 92: Midface | 60 (17.29) | 11 (6.5) | 49 (27.37) |
| Code 91, 92: Mandible, midface | 7 (2.01) | 0 | 6 (3.3) |
| Code 91, 92, 94: Mandible, midface, skull base | 4 (1.15) | 0 | 4 (2.2) |
| Code 92, 94: Midface, skull base | 3 (0.8) | 1 (0.5) | 4 (2.2) |
| Code 94: Cranial vault | 7 (2.01) | 1 (0.5) | 6 (3.3) |
| Total | 347 (100.0) | 168 (48.41) | 179 (51.58) |

**Table 6: Coefficient correlation**

| Helmet | Coefficient | SE | *T* | *P*>\|*t*\| | 95% CI |
|---|---|---|---|---|---|
| Orthopedic injuries | −0.1992143 | 0.61 | −3.23 | 0.01 | −0.3204-−0.0779 |

SE=Standard error; CI=Confidence interval

**Table 7: Odds ratio**

| Helmet | Odds ratio | SE | *Z* | *P*>\|*z*\| | 95% CI |
|---|---|---|---|---|---|
| Orthopedic injuries | 0.4411 | 0.11 | −3.16 | 0.002 | 0.26-0.733 |

SE=Standard error; CI=Confidence interval

## Discussion

A total of *N* = 347 individuals were included in the study. The mean age of the individuals was 33.7 (2–85) years, and the median age was 32 years. 81.55% (*N* = 283) were male and 18.44% (*N* = 64) were female [Table 1]. Among the individuals, 51.5% (*N* = 179) Table 2. A total of 25.07% (*N* = 87) individuals had orthopedic injuries and 16.42% (*N* = 57) individuals had orthopedic injuries who were not wearing helmets [Tables 3 and 4]. The most common type of injury was Type 1b followed by 1c [Table 5]. There was an increase in number of soft-tissue injuries on wearing a helmet as compared to that of without helmet. The individual without a helmet had mandibular and midfacial skeletal bone fractures (AOCMF Classification: Codes 91 and 92)[29] commonly [Table 5]. Our results have demonstrated that helmet wearing significantly influences the severity of hard-tissue injury and that helmet wearing can bring down the number of severe injuries, and hence saving lives [Tables 6 and 7]. The results also correlate with the previous studies.[16-23]

The pattern of RTAs in Mangalore has a similar trend as compared to the data published since 2002. The age, gender, and pattern of injury were similar to the previous studies[16-23,30] [Table 4].

The above findings can be explained based on the factors such as cost of the helmet, type of helmet, speed, quality of helmet, type of bike and safety features, and rate of protection by helmets. It is universally agreed that the primary cause of fracture is road collisions, and although car crashes prevail in all other age groups, motorcycle crashes (MCCs) are more frequent in adolescents.[24] In April 2012, Michigan repealed its 35-year-old universal motorcycle helmet law in favor of a partial helmet law, which permits motorcyclists older than 21 years old with sufficient insurance and experience to ride unhelmeted. Recently, a study by Saunders *et al*. (2018) aimed to determine its clinical impact of repeal. There were 1970 patients in the prerepeal analysis and 2673 patients in the postrepeal analysis. The results found that the patients were more likely to be unhelmeted and have traumatic brain injury. The patients required neurological interventions at a relative risk (1.4, *P* = 0.011). The authors concluded that there was an increased risk of traumatic injury and neurological interventions after the repeal policy and that there was a detrimental clinical impact on patients not wearing a helmet.[16] A similar study was conducted by Harvey *et al*. (2017)[17] The study findings were in similar correlation as that of Saunders *et al*. (2018) and our findings.[16,17]

On contrary, many states mention the importance of wearing helmet, but the laws do not indicate which type of helmet should be used. There are not many prospective studies on the type of helmet use and its clinical impact.[24-26] However, a study by Brewer *et al*. (2013) aimed to determine the impact of full-face helmets (FFHs) in reducing the craniofacial injuries.[18] The study revealed that facial fractures were present in 7% of the patients wearing FFH (95% confidence interval, 0.015–0.125) versus 27% (95% confidence interval, 0.164–0.376) of those wearing other helmet types (OH) (*P* = 0.004). In addition, skull fractures were present in 1% of patients wearing FFH versus 8% in those wearing OH (*P* < 0.05). While there was a trend for patients wearing FFH to have a lower incidence of traumatic brain injuries (13% vs. 25% in those wearing OH), this was not statistically significant (*P* = 0.053). There were

no differences in the Injury Severity Score, length of stay, or mortality between the two groups.[18] Another cross-control study by Yu *et al*. (2011) confirmed that half-coverage helmets provided motorcyclists the least protection from head injuries. Furthermore, wearing a loosely fastened helmet may compromise any potential protection.[19]

Although we have the evidence that helmet wearing is preventing significantly from detrimental effects of craniofacial injuries, some argue that helmet wearing is actually causing more accidents due to decreased rider vision and increased neck injuries. A Cochrane review by Liu *et al*. (2008) was conducted to add evidence to this argument and concluded that the risk of head injury is reduced by around 72% and the risk of death is also reduced. Therefore, wearing helmets, in reality, brings down the craniofacial injury and trauma and hence saves lives of the motorcyclists.[20] There is no evidence that helmets are causing decreased vision and neck injuries.[20] The findings from the Cochrane review have suggested that there should be wide implementation of policy on wearing helmets and the Road Traffic Department should be actively encouraged to implement helmet wearing policy all across the country.[20] The study on the quality of helmets and the impact of speed on helmets needs further investigation.[21]

Another important factor that influences individuals to nose use helmets is the cost of the helmet. The relationship between injuries sustained in a MCC by unhelmeted motorcyclists and the multitude of costs associated with those injuries has been a decades-long debate. The aim of Heldt *et al*. (2012) study was to delineate the medical costs associated with helmet use and nonuse in motorcyclists. The results demonstrate that medical costs due to a MCC for an unhelmeted motorcyclist were significantly higher than for a helmeted motorcyclist.[22]

It is unknown if standard helmets versus nonstandard helmets give more protection. This question arises if it is a developing country. We do not know the rate of protection offered by the helmets to prevent craniofacial trauma and injury.[23] In our study finding, we found that there was more soft-tissue injuries among helmet wearers than that of nonhelmet wearers. A similar finding was reported by Gopalakrishna *et al*. (1998)[31] The possible explanation for our interesting finding is that the design of the helmet and the material used in the helmet influence the soft-tissue injury. Many studies have suggested including rotational effects of impacts while checking the helmet quality. It considers the anatomy and biomechanical properties of different tissues. Siegkas *et al*. (2019) study found that adding the dilatant viscoelastic components on the interior surface of the liner of a high-performance helmet can reduce peak head accelerations as well as large strains and strain rates across the brain during oblique impacts.[32,33]

## Conclusion

Under the limitations of the study, we conclude that majority of the two-wheelers are not wearing helmets. This study has demonstrated that the impact of wearing helmet on the occurrence of craniofacial and orthopedic injuries is less.


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### Conflicts of interest

There are no conflicts of interest.


## References


1. Mason A. Demographic Transition and Demographic Dividends in Developed and Developing Countries. In: United Nations Expert Group Meeting on Social and Economic Implications of Changing Population age Structures. Vol. 31. Mexico City, A Mason New York: University of Hawaiian System; 2005.
2. India – Urbanization in India: Integral Part of Economic Growth; 2019. Available from: http://web.worldbank.org/archive/website01291/WEB/0__CO-22.HTM. [Last accessed on 2019 Mar 12].
3. Jagnoor J, Prinja S, Lakshmi PV, Aggarwal S, Gabbe B, Ivers RQ. The impact of road traffic injury in North India: A mixed-methods study protocol. BMJ Open 2015;5:e008884.
4. Ruikar M. National statistics of road traffic accidents in India. J Orthop Traumatol Rehabil 2013;6:1.
5. Jagnoor J. Road traffic injury prevention: A public health challenge. Indian J Community Med 2006;31:129-31.
6. Mohan D. Road safety in less-motorized environments: Future concerns. Int J Epidemiol 2002;31:527-32.
7. Dubos N, Varin B, Bisson O. A better knowledge of powered two wheelers accidents. Transp Res Procedia 2016;14:2274-83.
8. Bhagyanagar R, Kawal BM, Dwarakish GS, Surathkal S. Land use/land cover change and urban expansion during 1983-2008 in the coastal area of Dakshina Kannada district, South India. J Appl Remote Sens 2012;6:063576.
9. Geurts K, Thomas I, Wets G. Understanding spatial concentrations of road accidents using frequent item sets. Accid Anal Prev 2005;37:787-99.
10. Lawton R, Parker D, Manstead AS, Stradling SG. The role of affect in predicting social behaviors: The case of road traffic violations. J Appl Soc Psychol 1997;27:1258-76.
11. Elander J, West R, French D. Behavioral correlates of individual differences in road-traffic crash risk: An examination method and findings. Psychol Bull 1993;113:279-94.
12. Kapoor P, Kalra N. A retrospective analysis of maxillofacial injuries in patients reporting to a tertiary care hospital in East Delhi. Int J Crit Illn Inj Sci 2012;2:6-10.
13. Olusanya AA, Adeleye AO, Aladelusi TO, Fasola AO. Updates on the epidemiology and pattern of traumatic maxillofacial injuries in a Nigerian university teaching hospital: A 12-month prospective cohort in-hospital outcome study. Craniomaxillofac Trauma Reconstr 2015;8:50-8.
14. Pungrasmi P, Haetanurak S. Incidence and etiology of maxillofacial trauma: A retrospective analysis of King Chulalongkorn memorial hospital in the past decade. Asian Biomed 2017;11:353-8.
15. Meyyappan A, Subramani P, Kaliamoorthy S. A comparative data analysis of 1835 road traffic accident victims. Ann Maxillofac Surg 2018;8:214-7.
16. Saunders RN, Adams NS, Chapman AJ, Davis AT, Koehler TJ, Durling LT, *et al.* The impact of the repeal of Michigan's universal helmet law on traumatic brain injury: A statewide analysis. Am J Surg 2018;215:424-7.
17. Harvey JA, Gibreel W, Charafeddine A, Sharaf B. Helmet wear and craniofacial trauma burden: A Plea for regulations mandating protective helmet wear. Craniomaxillofac Trauma Reconstr 2017;10:197-203.
18. Brewer BL, Diehl AH 3rd, Johnson LS, Salomone JP, Wilson KL, Atallah HY, *et al.* Choice of motorcycle helmet makes a difference: A prospective observational study. J Trauma Acute Care Surg 2013;75:88-91.
19. Yu WY, Chen CY, Chiu WT, Lin MR. Effectiveness of different types of motorcycle helmets and effects of their improper use on head injuries.

Int J Epidemiol 2011;40:794-803.
20. Liu BC, Ivers R, Norton R, Boufous S, Blows S, Lo SK. Helmets for preventing injury in motorcycle riders. Cochrane Database Syst Rev 2008;1:CD004333. doi: 10.1002/14651858.CD004333.pub3.
21. Lopes Albuquerque CE, Nogueira Arcanjo FP, Cristino-Filho G, Mont'alverne Lopes-Filho A, Cesar de Almeida P, Prado R, *et al.* How safe is your motorcycle helmet? J Oral Maxillofac Surg 2014;72:542-9.
22. Heldt KA, Renner CH, Boarini DJ, Swegle JR. Costs associated with helmet use in motorcycle crashes: The cost of not wearing a helmet. Traffic Inj Prev 2012;13:144-9.
23. Amirjamshidi A, Ardalan A, Nainei KH, Sadeghi S, Pahlevani M, Zarei MR. Comparison of standard and nonstandard helmets and variants influencing the choice of helmets: A preliminary report of cross-sectional prospective analysis of 100 cases. Surg Neurol Int 2011;2:49.
24. Rocchi G, Fadda MT, Marianetti TM, Reale G, Iannetti G. Craniofacial trauma in adolescents: Incidence, etiology, and prevention. J Trauma 2007;62:404-9.
25. Lee MC, Chiu WT, Chang LT, Liu SC, Lin SH. Craniofacial injuries in unhelmeted riders of motorbikes. Injury 1995;26:467-70.
26. Johnson RM, McCarthy MC, Miller SF, Peoples JB. Craniofacial trauma in injured motorcyclists: The impact of helmet usage. J Trauma 1995;38:876-8.
27. Menon A, Pai VK, Rajeev A. Pattern of fatal head injuries due to vehicular accidents in Mangalore. J Forensic Leg Med 2008;15:75-7.
28. Jain A, Menezes RG, Kanchan T, Gagan S, Jain R. Two wheeler accidents on Indian roads – A study from Mangalore, India. J Forensic Leg Med 2009;16:130-3.
29. Audigé L, Cornelius CP, Kunz C, Buitrago-Téllez CH, Prein J. The comprehensive AOCMF classification system: Classification and documentation within AOCOIAC software. Craniomaxillofac Trauma Reconstr 2014;7:S114-22.
30. Kiran ER, Saralaya KM, Vijaya K. Prospective study on road traffic accidents. J Punjab Acad Forensic Med Toxicol 2004;4:12-6.
31. Gopalakrishna G, Peek-Asa C, Kraus JF. Epidemiologic features of facial injuries among motorcyclists. Ann Emerg Med 1998;32:425-30.
32. Siegkas P, Sharp DJ, Ghajari M. The traumatic brain injury mitigation effects of a new viscoelastic add-on liner. Sci Rep 2019;9:3471.
33. Cannell H, King JB, Winch RD. Head and facial injuries after low-speed motor-cycle accidents. Br J Oral Surg 1982;20:183-91.