



# The pattern of maxillofacial fractures: a study of 302 patients and a discussion of fracture classification

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## ABSTRACT

**Introduction:** The incidence and etiology of maxillofacial fractures vary widely between different countries. Understanding the cause and pattern of these injuries can assist in establishing clinical and research priorities for more effective treatment and prevention of maxillofacial injuries. The study aimed to evaluate the etiology and pattern of maxillofacial fractures in trauma patients hospitalized in Shariati Hospital in Tehran, Iran.

**Materials and Methods:** A prospective analysis of all maxillofacial fracture patients admitted to the Department of Oral and Maxillofacial Surgery was performed during a 12-month period from November 2010 to November 2011. Recorded data included age, sex, cause of trauma, and the pattern of maxillofacial fractures.

**Results:** A total of 302 consecutive patients were included in the study, with a male to female ratio of 3.4:1. Most patients (41.3%) were in the third decade of life (20-29 year-old). Motor vehicle accidents (MVA) were the most common cause of injury (50%), followed by interpersonal violence (30%). Mandible fracture was the most common fracture (41%), followed by midface fracture (34%). Fracture of the body of the mandible (24%) was the most common mandible fracture; and the most common midface fracture was zygomaticomaxillary fracture (32%).

**Conclusions:** In most other epidemiologic studies of maxillofacial fractures, MVA was the main cause of injury; and mandible the most common site of fracture. However, the vagueness and imprecision in the classification and nomenclature of maxillofacial fractures has led to confusing results that are difficult to compare.

**Keywords:** Maxillofacial Trauma, Epidemiology, Fracture.

## Introduction

Clinical and statistical analysis of maxillofacial fractures improves our understanding of the cause and pattern of these injuries. This understanding can assist in establishing clinical and research priorities for more effective treatment and prevention of maxillofacial injuries. The incidence and etiology of maxillofacial fractures vary widely between different countries [1-4]. This large variability is most probably due to environmental, cultural and socioeconomic

factors [3]. There are many epidemiologic studies of maxillofacial trauma reported from around the world, including some long-term studies with huge study population [5]. However, epidemiologic study of maxillofacial injuries never loses its significance, as the nature of these injuries is dynamic and changing with changes in our world.

## Patients and Methods

The study population included all trauma

**Table 1.** Epidemiologic studies of maxillofacial injuries in different countries.

Country	Review Period (Year)	Number of Patients	Most Common Age Group (Years)	Male:Female Ratio	Most Common Cause of Injury	Most Common Fracture	
Iran	2010-11	302	20-29	3.4:1	MVA	Mandible	Current Study
Netherlands	2000-10	579	20-29	2.4:1	MVA	Mandible	13
Korea	2003-07	318	20-29	3.2:1	Violence	Nasal	14
India	2000-05	2027	21-30	7:1	MVA	Mandible	15
India	1999-05	2748	21-30	3.7:1	MVA	Le Fort	4
Iran	2001-04	7200	20-29	11.9:1	MVA	Mandible	8
Brazil	1999-04	1024	21-30	3.9:1	MVA	Mandible	2
Bulgaria	1994-03	1706	21-30	4.6:1	Violence	Mandible	16
Pakistan	2001-02	702	20-29	5.2:1	MVA	Mandible	17
UAE	1999-02	230	20-29	11.7:1	MVA	Mandible	18
Turkey	1978-02	2901	0-10	3.4:1	MVA	Mandible	6
UAE	1998-01	144	16-20	4.8:1	MVA	Mandible	19
Iran	1996-01	237	20-29	8.1:1	MVA	Mandible	1
Iran	1987-01	2268	21-30	3.8:1	MVA	Mandible	3
Nigeria	1991-00	449	30-39	4.7:1	MVA	Mandible	20
Austria	1991-00	9543	20-29	2.1:1	Falling	Dentoalveolar	9
USA	1988-99	1429	?	2.8:1	MVA	?	21
New Zealand	1979-98	27732	F:15-19 M:20-24	3.7:1	Violence	Mandible	5
Jordan	1992-97	563	20-29	3:1	MVA	Mandible	22
Japan	1981-96	1502	10-19	2.8:1	MVA	Mandible	7
Norway	1989-91	169	16-30	3.6:1	Violence	Mandible	23
USA	1984-89	402	16-30	?	Violence	Mandible	24

?: Means that adequate data were not available in the article.

MVA: Motor Vehicle Accident

patients hospitalized in the Department of Oral and Maxillofacial Surgery of Shariati Hospital from November 2010 to November 2011. Shariati Hospital is one of the main centers for treatment of maxillofacial fractures in Tehran, Iran. Data were collected prospectively and included sex, age, cause of injury and type of maxillofacial fracture. All patients with midface and upper face fractures had axial and coronal CT scans. All patients with mandible fractures had at least a panoramic and a PA mandible radiographic view, and some of them had CT scans as well. All documents, including radiographs, as well as clinical evaluation of patients were done by two residents of oral and maxillofacial surgery. Both residents used the same criteria for classification of facial fractures.

Five different causes of maxillofacial fractures were identified including motor vehicle accidents (MVA) comprising of car accidents and motorcycle accidents, interpersonal violence, falling, occupational injuries, and sport injuries.

Mandible fractures are classified as the

following: dentoalveolar (involving the teeth and alveolar bone without involvement of the basal bone); symphysis (involving the area between canine teeth); body (involving the area distal to the canine and mesial to the third molar teeth); angle (involving the horizontal part of the mandible distal to the second molar tooth); ramus (involving the ascending ramus lower than the sigmoid notch (Fig. 1)); subcondylar

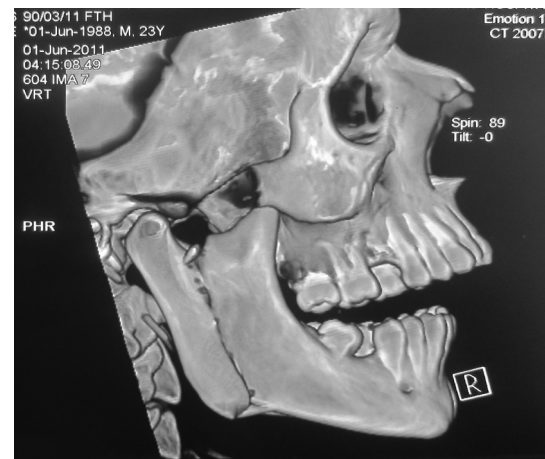


Fig. 1

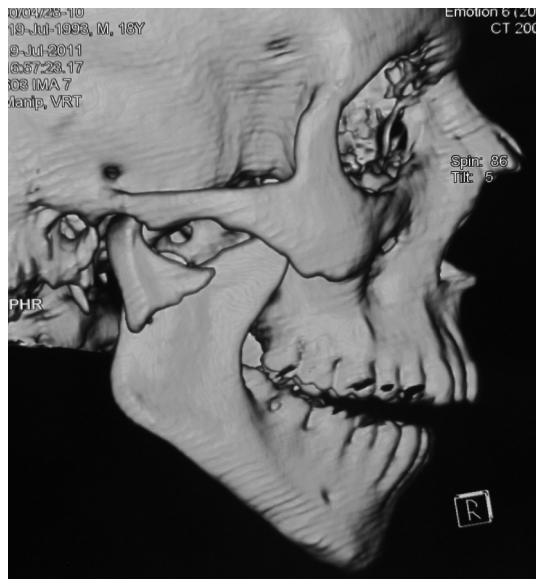


Fig. 2a.

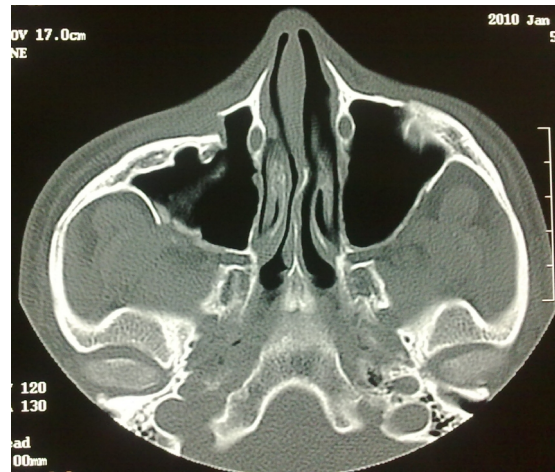


Fig. 3.



Fig. 2b.



Fig. 4



Fig. 2c.

(extending from the sigmoid notch inferiorly and obliquely toward the posterior border of the ramus (Fig. 2a)); condylar neck (involving the

condylar neck area inferior to the condylar head and superior to the sigmoid notch (Fig. 2b)); condylar head (intracapsular (Fig. 2c)); and coronoid.

Midface fractures are classified into zygomaticomaxillary complex (ZMC)(Fig. 3), tripod (Fig. 4), blow out, naso-orbito-ethmoidal (NOE), Le Fort, nasal, isolated zygomatic arch (Fig. 5), palatal, and maxillary dentoalveolar fractures. ZMC fracture involves both the maxillary sinus walls and the orbital process of the zygomatic bone, crossing the zygomaticomaxillary suture and involving the orbital floor and rim. In ZMC fracture, the zygomaticotemporal suture is not involved. Tripod fracture involves the zygomaticomaxillary, zygomaticofrontal, and zygomaticotemporal sutures as well as the lateral orbital wall and the orbital floor. Blow

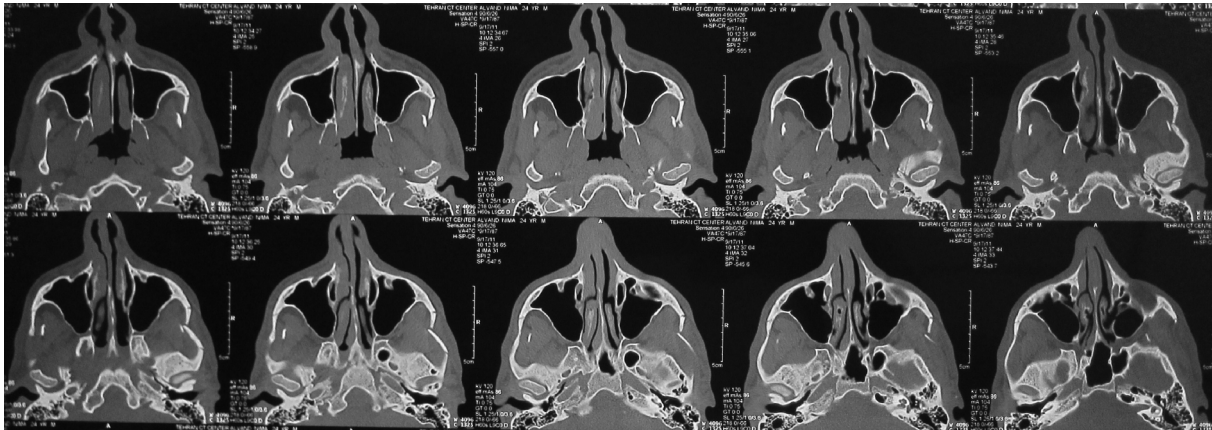


Fig. 5.

out fracture involves the orbital floor and/or the medial orbital wall without involvement of orbital rims and with no displacement of the zygoma. This is due to a direct trauma to the globe and not to the bones. NOE fracture involves the lacrimal bone, the frontal process of the maxilla, and the nasal bone associated with a clinically observable increase in intercanthal distance. Le Fort I fracture extends from the inferior half of the nasal aperture across the anterior and lateral maxillary sinus walls toward the maxillary tuberosity or pterygoid plates bilaterally. Le Fort II fracture extends from nasal bridge bilaterally toward the medial orbital walls, orbital floors, and pterygoid plates. Le Fort III fracture extends from the nasal bridge bilaterally towards the medial orbital walls, the lateral orbital walls, the zygomatic arches, and pterygoid plates. All Le



Fig. 6.

Fort fractures are associated with a mobile maxilla and/or anterior openbite, by definition. Isolated zygomatic arch fracture is a V-shape fracture of the zygomatic arch due to a direct trauma to the arch. Palatal fracture involves the palatal process of maxilla and/or the horizontal plate of the palatine bone. It may or may not include a part of the maxillary dentoalveolus. Maxillary dentoalveolar fractures involve only the alveolar process of the maxilla, without extension to the horizontal parts of the hard palate.

Upper face fractures are classified as the following. Isolated frontal fracture involves only the frontal bone without fracture of the frontal sinus walls, roof of the orbit, and superior orbital rim. Frontal sinus fracture is a fracture of the frontal bone that involves anterior and/or posterior walls of the frontal sinus without involvement of the orbit. Fronto-orbital fracture involves the frontal bone and the roof of the orbit, without involvement of the frontal sinus. Frontal sinus-orbital (FSO) fracture involves the frontal bone and extends into the roof of the orbit and the superior orbital rim, with involvement of the frontal sinus (Fig 6). Panfacial fracture involves mandible, midface, and upper face.

## Results

A total of 302 consecutive patients consisting of 234 (77%) males and 68 (23%) females with a mean ( $\pm$ SD) age of 31 ( $\pm$ 14.1) years were recorded. The youngest patient was 2 years old and the oldest had 82 years. There was no significant difference in age between male and female patients. As shown in Fig. 7, maxillofacial fractures were far more common in the third decade of life (20-29 years old;

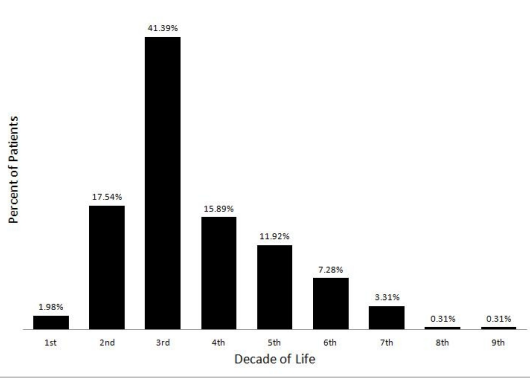


Fig. 7.

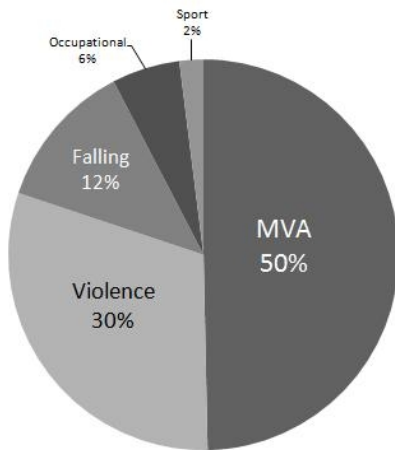


Fig.8.

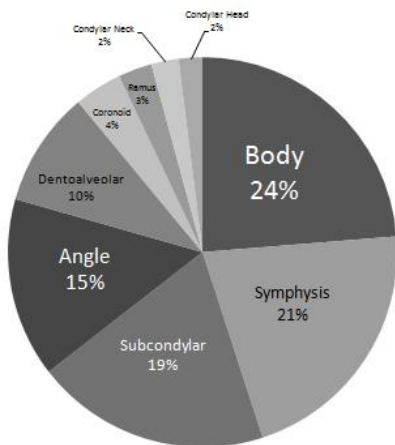


Fig.9.

41%). The most common cause of trauma was MVA (50%), followed by interpersonal violence (30%) (Fig. 8).

Of 302 patients, 125 individuals (41%) had only mandible fractures; 102 individuals (34%) had only midface fractures; 46 individuals (15%) had both mandible and midface fractures; 19 patients (6%) had both midface and upper

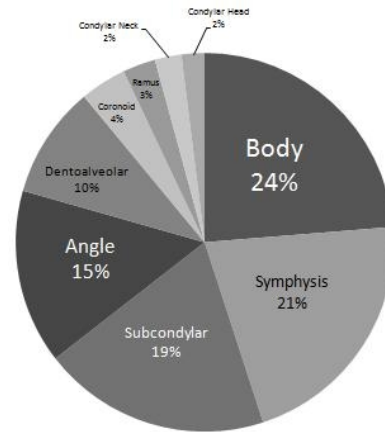


Fig. 10.

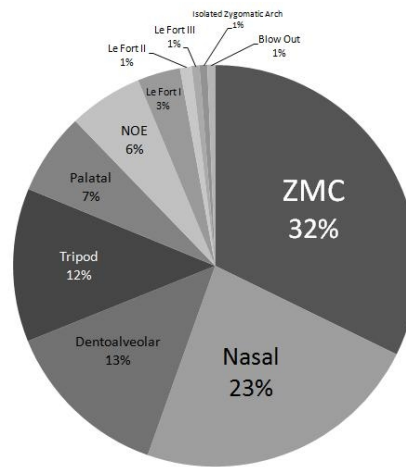


Fig.11.

face fractures; 6 patients (2%) had panfacial fractures; 2 individuals (1%) had only upper face fractures; and 2 patients (1%) had both mandible and upper face fractures (Fig. 9).

A number of 179 (59.27%) patients had mandible fracture, either isolated or in conjunction with other facial fractures. The most common cause of mandible fractures was MVA (41.8%). Of all mandible fracture patients, 55 individuals (30.72%) had only one fracture in the mandible and 124 (69.27%) of them had more than one fracture in the mandible. The most common site of fracture in the mandible was body (23.66%), followed by symphysis (21.26%), subcondylar (19.43%), angle (14.92%), dentoalveolar (9.85%), coronoid (3.94%), ramus (2.81%), condylar neck (2.25%), and condylar head (1.97%)(Fig 10). In those patients with only one fracture line in the mandible, the most common site of fracture was angle of the mandible (38.1%). In those who had more than one fracture in the mandible, the most common pattern of fracture

was angle fracture on one side and body fracture on the contralateral side (36.2%).

A number of 173 (57.28%) patients had midface fractures. The most common midface fracture was ZMC fracture (32.08%), followed by nasal (23.05%), dentoalveolar (13.39%), tripod (12.77%), palatal (6.54%), NOE (5.91%), Le Fort I (3.42%), Le Fort II (0.93%), Le Fort III (0.62%), isolated zygomatic arch (0.62%), and blow out fracture (0.62%) (Fig.11).

Only 29 patients (9.03%) had fracture in the upper face. We observed four different patterns of upper face fracture in these patients: fronto-orbital fracture in 9 patients, frontal sinus fracture in 8 patients, FSO fracture in 7 patients, and isolated frontal bone fracture in 5 patients.

### Discussion

Classification of facial fractures suffers from great variability and ambiguity that may cause several problems. First of all, it may preclude proper comparison of the results of different studies reporting on the incidence and pattern of maxillofacial injuries. Many articles reporting on the incidence of facial fractures have not precisely defined midface fractures [1-5]. In one study [1], midface fractures have been classified into maxillary, zygomatic, and zygomatico-orbital, with Le Fort III and dentoalveolar fractures as two subclasses of maxillary fractures. In this study, no reference has been made to palatal fractures. Does it mean that there had been no palatal fracture, or palatal fractures had been neglected, or misclassified under dentoalveolar category? In another study [2], no palatal or dentoalveolar fractures have been reported in 1024 maxillofacial fracture patients. In another study [3], 178 Le Fort III fractures were found in 2268 patients, but no palatal or NOE fractures were found. In a review of 2748 patients with maxillofacial fractures [4], it has been reported that 57% of patients with midface fractures had Le Fort fractures, but no reference had been made to palatal, maxillary dentoalveolar, isolated nasal, and isolated zygomatic arch fractures. In contrast, in a 20-year review of 27732 maxillofacial trauma patients [5], no reference has been made to the incidence of Le Fort fractures. More interestingly, in a 25-year review of 2901 maxillofacial trauma patients [6], no nasal fracture has been reported. These imprecision and vagueness call for attention. To allow for a global comparison and a better understanding, classification and nomenclature

of maxillofacial fractures should be standardized.

Second, ambiguity and lack of a consensus in fracture classification may cause great confusion and misunderstanding in interdisciplinary professional communications (for example, a telephone consultation between an ophthalmologist and a maxillofacial surgeon). In emergency situations fast and reliable communication between experts of different disciplines is very critical.

We have proposed a very precise and detailed definition of different facial fractures in the Patients and Methods section of this article. The main point of this classification is that both clinical and radiographic findings should be taken into account when classifying a midface fracture. For example, the most distinguishing features of a Le Fort fracture are the mobility of the maxilla as a whole and/or anterior open bite due to posterior premature contact. Fracture of pterygoid plates may or may not be seen in CT scan. Therefore, the diagnosis of Le Fort fracture is never a radiographic one; it is a clinicoradiographic diagnosis. The designation "Hemi Le Fort II" and "Hemi Le Fort III" is thus a fault and should not be used because it is impossible for the midface to become mobile unilaterally at the Le Fort II or Le Fort III level. However, "Hemi Le Fort I" is possible with the fracture extending through the hard palate. Not all patients whose CT scans suggest a classic Le Fort fracture, have Le Fort fracture in reality. The same is true about NOE fractures. Not all fractures that extends from the nose to the medial orbital wall are NOE fractures. They are NOE fractures only if associated with increased intercanthal distance.

Another important point in fracture classification is that a proper and useful classification should have some implications for treatment planning. NOE fracture implies that a canthopexy procedure is required. Isolated zygomatic arch fracture implies that simple closed reduction without fixation may be adequate, whereas a zygomatic arch fracture that is associated with Le Fort III or tripod fracture may require open reduction and rigid fixation. Similarly, closed treatment of a subcondylar fracture requires a more prolonged period of intermaxillary fixation (IMF) than that required for a condylar neck fracture. Furthermore, a subcondylar fracture lends itself better to an endoscopic-assisted approach than a condylar neck fracture. In our patients, we have

observed that the angle between fractured segments is more acute in condylar neck fractures compared to subcondylar fractures. Some authors have made a distinction between fractures of the symphysis and parasymphysis areas [7,8]. We believe that there is no advantage in making this distinction because fracture lines most often cross both areas. Furthermore, this distinction has not a clinical significance, as in both areas there is no limitation imposed by inferior alveolar canal; and the treatment plan is the same. In contrast, making distinctions in fractures of the upper face has clinical significance. For example, the treatment plan for a frontal sinus fracture is quite different from an isolated frontal fracture that most often does not require any surgical interventions at all [9-14].

Table 1 shows a summary of 22 different epidemiologic studies of maxillofacial fractures in different countries. A review of the table reveals that facial fractures most commonly occur in the third decade of life, with male predilection in all countries [15-18]. MVA is the leading cause of maxillofacial fractures in most countries, and mandible fracture is the most common facial fracture [19-24].

It seems that socioeconomic status of a community has a major impact on the cause, pattern, and severity of maxillofacial injuries. A 10-year review of 9543 maxillofacial trauma patients in Austria [9] from 1991 to 2000 revealed that the main cause of injury is falling due to activities of daily life and play accidents, followed by sport activities; while, all injuries due to MVA and violence combined were fewer than sport-related injuries. Furthermore, the majority of injuries were minor injuries of a dentoalveolar nature, without involvement of the facial bones. From 1990 to 2000, the Gross Domestic Product (GDP) per capita for Austria, as reported by the World Bank, was between 21000 and 30000. From 1996 to 2001, the GDP per capita for Iran was between 1500 and 1800. A 5-year review of 237 maxillofacial trauma patients in Tehran, Iran, from 1996 to 2001 revealed that the main cause of injury was MVA (54%), with mandible condyle and symphysis being most commonly involved [1]. A higher incidence of MVA-related injuries and more severe injuries may have an association with lower socioeconomic status. The higher the quality of motor vehicles and roads, the lesser the severity of maxillofacial injuries and the contribution of MVA in such injuries.

Tehran is a crowded metropolis with a population of about 8 million people. Our study reveals that MVA is still the most common cause of maxillofacial fractures (50%). A comparison between our results and a previous study<sup>1</sup> in Tehran reveals that the contribution of violence in causing maxillofacial injuries has increased from 10% to 30%.

It has been shown that airbag decreases both the number [10] and severity [11] of facial fractures in car accidents; and the use of seatbelts and airbags together offers a statistically significant reduction in facial fractures compared to the use of each of these restraints alone [12]. We think that the following recommendations could have the greatest impact on reducing the incidence of MVA-related injuries in Iran: improving road conditions; higher standards in car manufacturing; and more effective preventive education.

It should be mentioned that isolated zygomatic arch fractures and isolated dentoalveolar fractures, as well as isolated mandible and nasal fractures are routinely treated on an outpatient basis in our hospital. This study included those patients that were hospitalized for the treatment of their fractures. Therefore, the incidence of isolated zygomatic arch fractures and isolated dentoalveolar fractures reported in this study is not a true reflection of the incidence of these types of fractures in the general population.

### **Conclusion**

Understanding the nature, cause and pattern of maxillofacial injuries can assist in establishing clinical and research priorities for more effective treatment and prevention. A proper and useful classification can be useful for treatment planning as well.

**Conflict of interests:** The authors declared none.

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