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A systematic study on 3-D reconstruction computed tomography in cases of maxillofacial traumatic injuries

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ABSTRACT

Introduction: The skeletal anatomy of maxillofacial region is the most complex in the body. Injuries of this region is classified from isolated injuries which involves osseous components to complex maxillofacial injuries involving the entire facial skeleton. The aim of any imaging technique for maxillofacial injury is to evaluate the positions of anatomic elements in precision for both hard and soft tissues in spatial planes. The oldest method of imaging Maxillofacial injuries was the classic x-rays. The challenge of the classical method was the inability to represent all the bone structures of facial skeleton precisely and the very difficulty to access the elements of the soft tissue of face in detailed form. Computed tomography have replaced conventional x-rays and is now a very important tool of imaging for very precise evaluation of maxillofacial trauma and it's potency with the ability to detect the exact number and site along with the extent of fractures.

Materials and Methods: A systemic self-study was planned to analyze the best choice of imaging techniques for cases of maxillofacial traumatic injuries. With the application of electronic databases we searched PubMed, Google Scholar, Web of Science, Clinical Trial Gov, Medline Plus, health line, John Hopkins Medicine which were published in English language. This systemic self-study have reviewed the facts which were published earlier to determine the ideal choice of imaging techniques for any trauma to maxillofacial region. Vast analysis and along with proper examination of data to evaluate with final conclusion.

Observation and Discussion: Based on our systemic self study we observed this fact that maxillofacial injuries are one of the most frequently encountered injuries which are very often admitted in emergency department. With the revolution of technology in healthcare, today 3D Computed tomography has become the ultimate and primary imaging method because of its significant technical improvement.

Conclusion: We concluded that 3D Computed Tomography imaging is very useful for assessing the severity of midface fracture and injury. The reason for 3D Computed Tomography being chosen as imaging choice is just because the 3D image displays the spatial relationships of fracture segments which are in dislocated form and assists surgeons with better graphic display of the actual anatomic presentation which further guides and assists in the management planning and surgical approach in operation Theatre. Hence 3D Computed tomography is the imaging method of choice for an accurate diagnosis which have totally replaced conventional radiography due to its inability to depict the complex anatomical structure of maxillofacial region. This is the reason 3D Computed Tomography is regarded as golden choice in cases of oro-maxillofacial trauma.

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1. Introduction

A computed tomography scan is such a revolutionary medical imaging techniques which combined series of X-ray images from various angles with the application of computer processing to create cross-sectional images of vascular structures, bones and soft tissues in detail form of our body. Computed Tomography Scan was previously recognized by the name as Computed Axial Tomography scan or CAT scan. Maxillofacial trauma also known as facial trauma which is typically represented as any injury to face or jaws. Facial trauma commonly affects upper jaw, lower jaw, cheek, nose, forehead or eye socket.

The oldest method of imaging Maxillofacial injuries was the classic x-rays. The challenge of the classical method was the inability to represent all the bone structures of facial skeleton precisely and the very difficulty to access the elements of the soft tissue of face in detailed form.¹ The conventional X-ray were found to be very insensitive to fracture of skull base and facial skeleton. This was a major indication for discarding the use of conventional X-rays in case of head trauma.

The aim of any Imaging technique for maxillofacial injury is to evaluate the positions of anatomic elements in precision for both hard and soft tissues in spatial planes.

The skeletal anatomy of maxillofacial region is the most complex in the body. Injuries of this region is classified from isolated injuries which involves osseous components to complex maxillofacial injuries involving the entire facial skeleton. Diagnostic imaging has traditionally played central role in providing information essential in initial diagnosis and treatment of these injuries. The introduction of CT in late 1970s and early 1980s represented a major advancement. This was followed by software capable of generating 3-D reformatted images.

The late 1980s and 1990s witnessed significant advancement capable of performing high speed helical or spiral CT, which can scan acutely traumatized patients in a matter of seconds. Spiral CTs represent state of the art imaging for the patients with severe maxillofacial injuries. Computed tomography have replaced conventional X-rays and is now a very important tool of imaging for very precise evaluation of maxillofacial trauma and it's potency with the ability to detect the exact number and site along with the extent of fractures.

2. Materials and Methods

A systemic self-study was planned to analyze the best choice of imaging techniques for cases of maxillofacial traumatic injuries. With the application of electronic databases we searched PubMed, Google Scholar, Web of Science, Clinical Trial Gov, Medline Plus, health line,

John Hopkins Medicine which were published in English language. This systemic self-study have reviewed the facts which were published earlier to determine the ideal choice of imaging techniques for any trauma to maxillofacial region. Vast analysis and along with proper examination of data to evaluate with final conclusion.

3. Observation and Discussion

Based on our systemic self study we observed this fact that oro-maxillofacial injuries are one of the most common encountered injuries which are very often admitted in emergency department. With the revolution of technology in healthcare, today 3D Computed tomography has become the ultimate and primary diagnostic method because of its technical improvement. In terms of anatomy our human face could be organized in five anatomical regions:

1. Nasal
2. Orbital
3. Zygomatic
4. Maxillary
5. Mandibular

Nowadays with the revolution of technology in transportation has led to increase in magnitude of road traffic accidents followed by increase in series of violence have transformed this trauma a type of social disease.² So we can state this fact based on our review of many etiological studies of Maxillofacial Traumatic Injuries, Road traffic accidents (RTA) and violence are the leading causes of oro-maxillofacial injuries.

3.1. Etiology of maxillofacial traumatic Injuries

There are various forms of etiological factors which could contribute to maxillofacial injuries. But according to our strict observational statistics based on previous statistical studies we can report that frequent source etiology of maxillofacial injury was road traffic accident (RTA) which is followed by fall and violence very less reported. The majority of the victims of RTA who were injured fall in the mean age group of 20-40 years. The most common site which were affected in maxillofacial trauma where malar bone and maxilla followed by mandible.³ Furthermore it is also reported that in RTA, two wheelers were the most frequent cause of the accident.

The other predominating etiological factors includes:

1. Falls from heights
2. Sports injuries
3. Epilepsy
4. Violence

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Fig. 1: Conventional X-rays of maxillofacial traumatic injuries

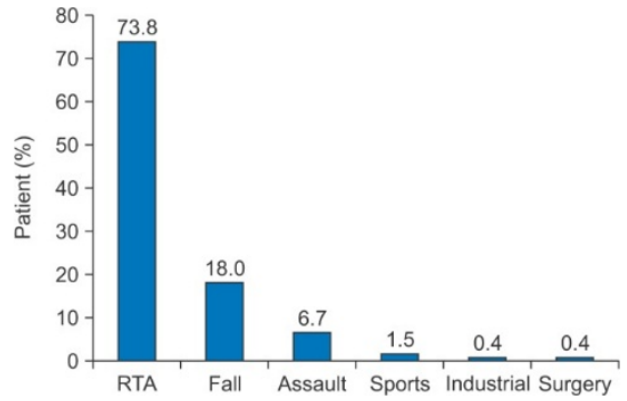


Fig. 3: Etiology of Maxillofacial injury Source: 10.5125/jkaoms.2016.42.4.174

Types of vehicle in RTA (n=22)

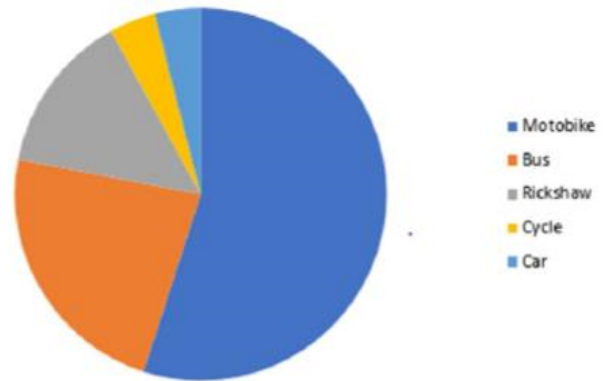


Fig. 4: Types of vehicles in RTA Source: <https://lupinepublishers.com/>



Fig. 2: Third dimensional computed tomography of maxillofacial traumatic injuries

4. Conventional radiology in maxillofacial traumatic injuries

In earlier times, the conventional radiography played a very significant role in diagnosis of maxillofacial fractures and other associated facial trauma . In the period of 1940-1950, there were numerous radiographic techniques which were reported significantly for mandibular & pan facial injuries.

Fractures in mandible were identified using a combination of lateral oblique, occlusal transcranial and posterior anterior projections whereas midface fractures includes the use of the selected plain film projections.⁴

5. Computed tomography in maxillofacial traumatic injuries

The word tomography is derived from a Greek word Tome meaning slice and graphene which refers to write.

In the period of 1970-1980, Godfrey Hounsfield & Allan McCormack have introduced computer processing. The

Nobel prize in Physiology or Medicine had been awarded to both Allan and Hounsfield for their revolutionary discovery of Computed Tomography in the year 1979.

At that time Computed tomography was the first ever device made which had the potential of visualization of soft tissues as well as hard tissue of facial bones by image processing enhancement. The demand of the use of CT scans has been dramatically increasing in many countries from last two decades.⁵

In 2007 it was estimated that 72 million scans were performed and 80 millions in 2015 in United States.⁶ Computed tomography has become the key diagnostic modality in the precise evaluation of head trauma.

In the late 1980s, spiral Computed Tomography were introduced which were an innovation in advancement in technology of imaging. In spiral Computed Tomography, patient is moved continuously, as a result image data which are acquired as spiral rather than in the form of series of slices.⁷ According to one study by Marbowitz, Coronal Computed Tomography have been reported to be the most efficient in accurate methods in the diagnosis of mandibular fractures. He had also reported that Axial Computed Tomography detected significantly few angle fractures (60%) then standard radiographs(98%) and Coronal Computed Tomography (100%) and also identified that lack of fracture displacement was the single most important factor in missed fractures with all modalities.⁸ Another significant study by Kapil Saigal in 2005 who have reported that 3D CT is the most useful imaging comminuted fracture of the middle third of face and zygomatic maxillary fracture.⁹ In another case report by Hassel who have demonstrated that 3D CT have altered these surgical procedures particularly in the case of naso orbital ethmoid fractures.¹⁰

Another study by Ohkawa in 1997 which significantly reported that both 2D-CT and 3DCT techniques have shown a similarity in terms of sensitivity for the diagnosis of Mandibular fractures specifically. In the year 1991, Rhea had observed and reported that 3D images had provided an easy detection and depiction of specific characteristics of defects in midface, skull vault defects and facial asymmetries along with a clear localization of fractures sites. So based on the above facts we can state that axial and coronal CT are imaging choice for diagnosis of mandibular fractures.

So we can conclude our systemic self study by stating Computed Tomography is the imaging method of choice for an accurate diagnosis by depicting the most complex anatomical structures of Oro maxillofacial region. 3D computed tomography have helped many complicated cases in detecting the exact site of maxillofacial trauma, type and extent of fracture in maxillofacial areas and it's following displacement of fragments and soft tissue injuries. In conventional X-ray it was observed and noted the fact that

overlapping nature of bone and its inability to visualize soft tissue swelling and fracture displacement especially in the region of maxillofacial region where very less reliable and found to be less useful.

Computed tomography has helped in solving this problem and has proved to be superior to conventional radiograph in diagnosing additional number of fractures in maxilla, mandible and nasal ethmoid region.

Coronal and axial images were found to be significantly more diagnostic in fractures site such as zygomatico maxillary complex, orbital floor, lateral maxillary wall and anterior maxillary wall.

6. Conclusion

So thereby after our vast analysis we can conclude that 3D Computed tomography imaging has become the key of diagnosis in the evaluation of maxillofacial trauma. We have also observed that in conventional radiography which were very insensitive to fracture of skull base and facial skeleton. Also conventional radiograph had overlapping nature of bones and inability to witness this soft tissue swelling and fracture displacement especially in the region of maxillofacial area which altogether makes conventional X-ray very less reliable and useful. With the innovation and advancement in technology of imaging in healthcare brought by two brilliant scientists Honsfield and Allan with the application of computer processing introduced computed tomographic in the field of medicine. At that time Computed Tomography was the first ever medical device to be introduced which could visualize both hard and soft tissue official bones by image processing enhancement.

Computed Tomography have proved to be superior to conventional radiography in diagnosing additional number of fractures in zygoma, maxilla, mandible and naso-ethmoid region.

Thus it could be concluded that 3D Computed Tomography imaging is very useful for assessing the severity of midface fracture and injury. The reason for 3D Computed Tomography being chosen as imaging choice is just because the 3D image displays the spatial relationships of fracture segments which are in dislocated form and assists surgeons with better graphic display of the actual anatomic presentation which further guides and assists in the management planning and surgical approach in operation theatres.

Hence 3D Computed tomography is the imaging method of choice for an accurate diagnosis which have totally replaced conventional radiography due to its inability to depict the complex anatomical structure of maxillofacial region. This is the reason 3D Computed Tomography is regarded as golden choice in cases of oro-maxillofacial trauma.

7. Source of Funding

None.

8. Conflict of Interest

None.

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