ISSN 2304-8336. Проблеми радіаційної медицини та радіобіології = Problems of Radiation Medicine and Radiobiology. 2023. Вип. 28.

УДК: 004.891.3:611.92:616-089.843.23

К. Шунмугавелу[1]✉, Х. Каннапан[2], П. Вайшнави[3], Е. С. Дхинакаран[2], С. Лаванья[4], Б. Кумар[5]

[1]Шпиталь медичного коледжу та науково-дослідний інститут ПСП, Тамбарам–Канчіпурам Мейн Роад, Орагадам, Панруті, округ Канчипурам, штат Таміл Наду, 631604, Індія
[2]Шпиталь медичного коледжу та науково-дослідний інститут Шрі Баладжі, Хромпет, Ченнаі, штат Таміл Наду, 600044, Індія
[3]Стоматологічний коледж і шпиталь Шрі Венкатешвара, Офф.Олд. Махабаліпурам Роад, Ніар Навалур Таламбур, Ченнаі, штат Таміл Наду, 600130, Індія
[3]Онкологічний центр Малабар, Талассері, штат Керала, 670103, Індія
[3]Стоматологічний коледж і шпиталь Бхараті Відьяпіт, Наві Мумбаі, штат Махараштра, 400614, Індія

ЗАСТОСУВАННЯ ТРИВИМІРНОЇ КОМП'ЮТЕРНОЇ ТОМОГРАФІЇ ОБЛИЧЧЯ ПРИ ВІЗУАЛІЗАЦІЇ ОБЛАСТІ ГОЛОВИ ТА ШИЇ – ОГЛЯД

Прогрес технології 3D-комп'ютерної томографії обличчя зробило революцію в діагностиці, що дозволяє покращити результати лікування. Обмеження звичайних 2D-методів візуалізації звужують терапевтичні можливості й часом зумовлюють помилки в лікуванні. Незважаючи на економічну затратність 3D-комп'ютерної томографії, її переваги переважують недоліки. Метод використовується, зокрема, в хірургії, ортодонтії, протезуванні та криміналістиці.

Ключові слова: 3D-КТ обличчя, протезування, ортодонтія.

Проблеми радіаційної медицини та радіобіології. 2023. Вип. 28. С. 544–548. doi: 10.33145/2304-8336-2023-28-544-548

K. Shunmugavelu[1]✉, H. Kannapan[2], P. Vaishnavi[3], E. C. Dhinakaran[2], S. Lavanya[4], B. Kumar[5]

[1]PSP Medical College Hospital and Research Institute, Tambaram – Kanchipuram Main Road, Oragadam, Panruti, Kancheepuram district, Tamil Nadu, 631604, India
[2]Sree Balaji Medical College Hospital and Research Institute, Chrompet, Chennai, Tamil Nadu 600044, India
[3]Sri Venkateswara Dental College & Hospital, Off.Old Mahabalipuram Road, Near Navalur Thalambur, Chennai, 600130, Tamil Nadu, India
[4]Malabar cancer centre, Thalassery, Kerala, 670103, India
[5]Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai, Maharashtra, 400614, India

APPLICATIONS OF THREE DIMENSIONAL FACIAL COMPUTED TOMOGRAPHY IN HEAD AND NECK REGION – A REVIEW

3D facial CT has evolved and revolutionized diagnosis leading to better management. The limitations of conventional 2D methods limit the therapeutic options related to leading to an erroneous treatment. Although 3D facial CT is expensive, its advantages outweigh the cons. They are used in surgery, prosthetic replacement, orthodontics and forensics.

Key words: 3D facial CT, prosthetic, orthodontics.

Problems of Radiation Medicine and Radiobiology. 2023;28:544-548. doi: 10.33145/2304-8336-2023-28-544-548

✉ Картік Шунмугавелу, *e-mail: drkarthiks1981@gmail.com*
✉ Karthik Shunmugavelu, *e-mail: drkarthiks1981@gmail.com*

INTRODUCTION

CT scan or computed tomography uses computer-processed combinations of multiple X-ray measurements taken from different angles to produce tomographic (cross-sectional) images (virtual «slices») of a body. Computed tomography was first introduced 30 years ago. It has since revolutionized diagnosis [1, 2]. CT has resulted in better surgery, diagnosis, treatment of cancer, trauma, stroke and cardiac conditions [3–5]. 3D images provide accurate and more detailed information for the diagnosis and treatment planning of facial asymmetry quantitative measurement and comparison between the right and left sides of the structures [6, 7].

2 AND 3 DIMENSIONS

The limitations of conventional 2D methods limit the therapeutic options related to leading to an erroneous treatment. 3D CT allows the exact determination and visualization of both the skeletal structures and soft tissues paradigm in 3D without the superimposition of anatomical structures [8, 9]. 3D images can also be reconstructed using a process of creating digital representations of objects from multiple 2D images. Non-rigid models can be constructed using statistical techniques described as learning-based algorithms, 3D 'morphable'-model algorithms and coupled basis function network algorithms [10, 11]. Agarwal et al. [12] studied the efficiency of CT scan and their 3D images for evaluating maxillofacial trauma as compared to conventional radiographs and reported that CT scan provides the most effective, safe and reasonably rapid diagnosis of the complex pattern of multiple fractures of facial skeleton along with soft tissue injuries along with intracranial and cervical spine injury as compared to conventional radiographs. Markose et al. [13] evaluated the accuracy of measurements and dimensions in 3D CT reconstruction and reported that, analysis on 3D CT reconstructed images by means of a CAD software caused fewer identification problems, and was accurate and reliable.

3D CT SYSTEM

Three dimensional (3D) computed tomography imaging is a technique that uses conventional CT data to reconstruct an image for viewing all three planes of viewing. Computer tomography (CT) measures the amount of X-ray transmission through an object in three dimensions. The digital data generated are matched to a density scale to display a pre-determined image layer on a monitor. The beam rotates around the patient, the computer then collates and combines all the readings from the detectors to a 3D digital image matrix of pixels [14]. Using 3D CT areas of clinical interest can be isolated by volume rendering technique from the patient and viewed in a variety of orientations, which is not possible using other methods and in complex anatomical images such as facial bones [15, 16].

ADVANTAGES OF 3D FACIAL CT

It provides the most effective, safe and reasonably rapid diagnosis of the complex pattern of multiple fractures of facial skeleton along with soft tissue [12], (Fig. 1, 2). All raw data can be obtained in a single turn. Patient's length of stay is reduced increasing patient's satisfaction [17]. Reliable imaging information is necessary to elucidate emergent injuries, to preoperatively plan reconstruction of functional areas [18]. Reduces amount of radiation exposure is an important advantage since the time required to obtain the images is also reduced. Inclusion of soft-tissue landmarks, particularly those around the eye in the assessment of facial asymmetry granted an effective means of instituting a more precise facial midline in 3D facial CT image reorientation [19], (Fig. 3). Tyndal et al. [20] reported that 3D CT is more accurate when testing the validity and reliability of 3D CT for quantification of positional changes of the condyle in a dried human skull and that 3D CT measurement techniques were superior to those in which measurement obtained directly from the original CT slices.

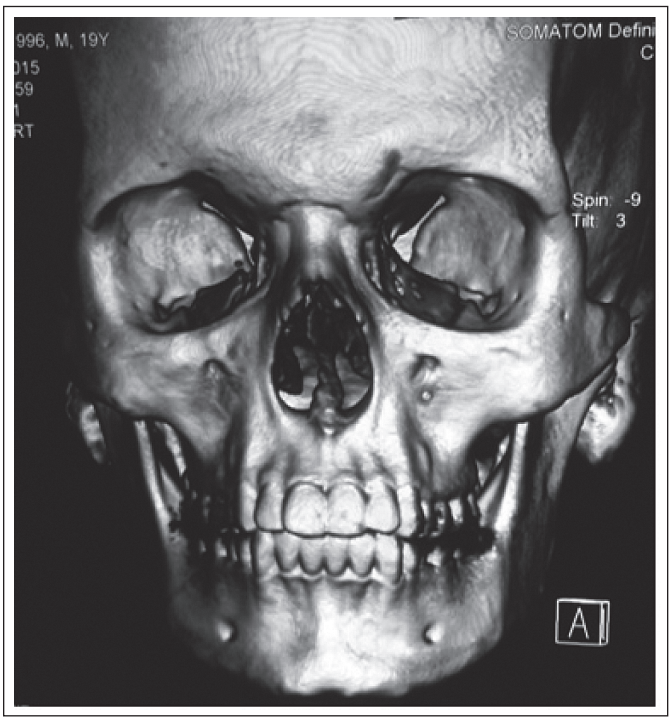

Figure 1. Three dimensional frontal view

ISSN 2304-8336. Проблеми радіаційної медицини та радіобіології = Problems of Radiation Medicine and Radiobiology. 2023. Вип. 28.

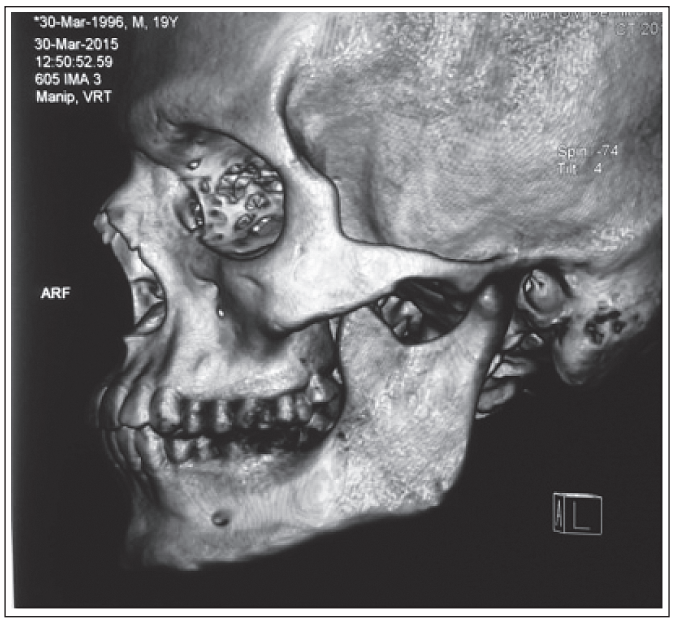

Figure 2. Three dimensional left lateral view

Figure 3. Three dimensional oblique view

LIMITATIONS OF 3D FACIAL CT

The equipment is expensive, and not available in every hospital. Lesions far away from the sections can be skipped. Another major limitation is foreign objects like restoration and prosthetics can create artefacts. In addition, the data may be insufficient compared with other soft-tissue imaging techniques.

APPLICATIONS OF 3D FACIAL CT

3D facial is used clinically to monitor facial growth and development in three dimensions, aid in planning surgical cases including cosmetic surgery of the face and neck, aid diagnosis and correction of craniofacial deformities including cleft lip and palate, and help construct maxillofacial prosthetics. In Orthodontics, when used in conjunction with standardised intraoral photographs, the initial 3D intraoral scans can be used to monitor tooth movement and alert the clinician when certain treatment milestones have been reached and when concerns arise regarding treatment progress [11–21]. 3D-CT can be used to asses craniometric patterns for individual identification in forensic dentistry [22]. It can also be used for post-mortem identification which can show internal findings related to the cause of death [23].

APPLICATIONS OF CONE BEAM COMPUTED TOMOGRAPHY

Implant position, anatomy of residual ridge, bone density evaluation, edentulous are visualization, bucco-lingual width of alveolar bone and cortical plate can be assessed in relation to implant dentistry. Proximity of vital structures, mandibular canal visualization-mapping, location of incisive canal, mental foramen, lingual foramen, submandibular fossa, maxillary sinus, greater palatine foramen, unerupted third molars and their proximity to mandibular canal can be delineated for presurgical evaluation. Paranasal sinuses such as sphenoid, ethmoid, maxillary and frontal, anatomy, pathology, opacities, proximity to vital structures can studied in detailed manner. In orthodontics, buccolingual root position, root resorption, cephalometric analysis, skeletal jaw relationships and cross sectional view without superimposition can be done. Airway analyses of nasal cavity, nasopharynx, oropharynx, hypopharynx and nasal cavity, in patients with obstructive sleep apnoea and in case of neoplasms, enlarged pharyngeal and palatine tonsils can be done. In endodontics, tooth morphology, location, number of pulp canals, size of pulp chamber, calcification, root morphology, fracture, and dental caries can be assessed.

ADVANTAGES OF CBCT

Image accuracy, limitation of xray beam, dose reduction, rapid scan time, reduction of image artifact and imaging display modes for maxillofacial region are the main advantages of CBCT over conventional CT [24].

CONCLUSION

Three dimensional facial computed tomography plays an important role as a primary investigation from the hospital point of view and mindset of patient. Pathology of bony tissue which might be of congenital or traumatic in origin along with exact bony architec-

ture renders an immense help for clinician from treatment point of view. Majority of the emergency medicine departments in colleges or hospitals prefer three dimensional facial computed tomography than two dimensional panoramic radiography. Correction of facial asymmetry in relation to maxilla and mandible relies largely upon the three dimensional units of skeletal system which can be accurately screened by 3D facial CT. Reduced data acquisition and reconstruction times are major boon for 3D facial CT in relation to maxillofacial injuries, complexe mandibular-midfacial trauma, oral-maxillofacial pathologies and skeletal-dental asymmetry.

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ISSN 2304-8336. Проблеми радіаційної медицини та радіобіології = Problems of Radiation Medicine and Radiobiology. 2023. Вип. 28.

INFORMATION ABOUT AUTHORS

Karthik Shunmugavelu – BDS, MDS OMFP, MSC London, MFDSRCS England, MFDSRCPS Glasgow, Faculty Affiliate RCS Ireland, Affiliate RCS Edinburgh, MCIP, FIBMS USA, MASID AUSTRALIA, Senior Resident, Consultant Dental Surgeon / Consultant Oral and Maxillofacial Pathologist, Department of Dentistry/Oral and Maxillofacial Pathology, PSP Medical College Hospital and Research Institute, Tamil Nadu, India, ORCID ID: 0000–0001–7562–8802

Harish Kannapan – Assistant Professor, Department of Radiology, Sree Balaji Medical College and Hospital, Chrompet, Chennai, India, ORCID ID: 0009–0009–3651–3039

P. Vaishnavi – BDS, Sri Venkateswara Dental College & Hospital Off.Old Mahabalipuram Road, Near Navalur, Thalambur, Chennai, Tamil Nadu, India

Evangeline Cynthia Dhinakaran – MBBS, MD Pathology Senior Resident, Department of Pathology, Sree Balaji Medical College Hospital and Research Institute, Chrompet, Chennai, Tamil Nadu, India, ORCID ID: 0000–0003–2194–6455

S. Lavanya – MDS Oral and Maxillofacial surgery, Fellowship in Oral Oncosurgery, Senior Resident, Department of Head and Neck Surgical Oncology, Malabar cancer centre, Thalassery, Kerala, India, ORCID ID: 0009–0006–1055–0964

Barun Kumar – MDS Oral and Maxillofacial Surgery, Associate Professor, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Navi Mumbai, India, ORCID ID: 0000–0003–2641–3498

Received: 21.08.2023