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Role of Intraoral Scanners in Pediatric Dentistry

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Abstract

Intraoral Scanners (IOS) are devices which are used for capturing direct optical impressions in dentistry. They are handheld devices used to directly create digital impression data of the oral cavity. Light source from the scanner is projected onto the scan objects, such as full dental arches, and then a 3D model processed by the scanning software will be displayed in real-time on a touch screen. Pediatric dental patients requiring dental prostheses is considered the most challenging for dental professionals owing to managing the children's behavioural problems, gagging reflex, foreign body aspiration, and choking (breathing) concerns. The conventional impression-making procedures in young children are regarded as quite cumbersome and difficult due to several clinical factors in dentistry. Pediatric dentistry is evolving to minimise the disadvantages of traditional techniques by introducing advanced digital intraoral scanners in the field of pediatric dentistry. Thus this paper reviews the application of intraoral scanners in pediatric dentistry.

Keywords: Digital Impression, Intraoral Scanner, Pediatric Dentistry

1. Introduction

Delivering top-rated dental care to pediatric patients and kids with unique care wishes is a primary goal in pediatric dentistry. However, modern evidence-primarily based dental innovations and advancements should be included in pediatric dental services to supply the gold standard of oral health care and additionally to instil a positive dental attitude and behaviour toward dentistry. Pediatric dental patients requiring dental prostheses such as removable space maintainers, resin-based partial dentures, customized mouth guards, occlusal splints, prosthetic crowns, myofunctional appliances, and habitbreaking appliance undergo impressionmaking procedure, that is considered to be the most challenging for pedodontist owing to manage the children's behavioural problems, gagging reflex, foreign body aspiration, and choking concerns[1]. The conventional methods of fabrication of the dental prosthesis and appliances for managing oral and dental problems in pediatric dental patients also pose many difficulties such as prolonged and multiple dental appointments followed by delayed delivery of dental appliances/prostheses, and discrepancies in the accuracy of the fitting of the prosthesis. Pediatric dentistry is evolving to minimise the disadvantages of traditional techniques by introducing advanced digital intraoral scanners in the field of pediatric dentistry. The intraoral scanner is a handheld device which is used to directly create digital impression data of the oral cavity. Light source from the scanner is applied onto the scan objects, such as full dental quadrants, and then a 3D model that is processed by the scanning software will be displayed in real-time on a touch screen. The device provides accurate detail of the hard and soft tissues that are located in the oral area using high-quality images. Intraoral scanners provide more accurate impressions, easier treatment planning, case acceptance, communication with laboratories, reduced operative time and reduced treatment time[2].

It has become a popular choice for clinics and dentists due to short lab procedures and excellent 3D image outputs. Modern dentistry is evolving with each passing day and there is always a race to overcome the demerits of previous ideas and innovation. The implementation of intraoral scanners device in dental practices can be

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marked as a revolutionary step towards digital workflow in pediatric dentistry[3].

1.1 Development of Intraoral Scanners

During the 18th century, methods of taking impressions and making models were already available. The advent of intraoral digital scanners coincided with the development of Computer-Aided Design and Manufacturing (CAD/CAM) technology and the 1984 introduction of Chairside Economical Restoration of Esthetic Ceramics (CEREC).

- In the 1970s, the concept of computer-aided design/computer-aided manufacturing was first introduced in dental applications by Dr. Francois Duret. By 1985, the first intraoral scanners become commercially available, used by labs to fabricate precise restorations.
- In 2001, Cadent introduced the OrthoCAD* system for the production of 3D digital models, virtual setups, and indirect-bonding trays.
- In 2006, Cadent developed the in-office iTero* digital impression system, which by 2008 was capable of full-arch intraoral scanning in late 2009, Cadent launched the iOC* system for iTero users.
- Align Technology purchased Cadent in 2011, allowing clinicians with iOC to begin submitting 3D digital scans in place of physical impressions for the fabrication of Invisalign appliances[4].

1.2 Parts of Intraoral Scanners

1. A data acquisition unit, that collects the data from the surface of the prepared teeth and neighbouring structures and further converts them to virtual impressions.

- **Wand:** It is the portion of the data acquisition unit which emits the light on the object and collects the data.
- **Point emission**: Light is being projected from certain points of the wand.
- **Network emission**: Light is projected as a line or mess.

2. Software for designing virtual restorations anchored in virtual impressions and setting up all the milling parameters.

- Open access system- CS 3600, TRIOSM by 2 shapes.
- Close access system- Sirona Bluecam or Omnicom (up to 2nd gen).
- Partially open access system-Lava[5].

1.3 How do Intraoral Scanners Work?

An intraoral scanner consists of a handheld camera wand, a computer and software.

The small, smooth wand is connected to a computer that runs custom software which helps in processing the digital data that is sensed by the camera. After that, insert the scanning wand into the patient's mouth and gently move it over the surface of the teeth. The wand will automatically capture the size and shape of teeth. And then the real-time images on the computer can be viewed, which can be magnified and manipulated to enhance details.

Figure 1. Parts of intraoral scanner - Computer monitor, hand held camera wand.

1.4 Scan Pathway

- The pathway used to scan the edentulous maxilla should start with the crest of the ridge, then extended to cover the palatal area, and finally captured the buccal and labial vestibules.
- Scanning the mandible should start with the crest of the ridge, then extend to the vestibules, and finally cover the lingual border extensions.
- The entire buccal and the labial vestibules should be done in one pass, as recapturing a missed area will result in a different position of the reflected soft tissue which leads to an error in the digital impression.
- Scanning can be Exterior-interior, sequential, sextants or quadrants. The scanned object should be positioned at the centre of an acquisition area, the camera should

be at the distance between 5-30mm of the scanned surface and the wand angle should be 45-90°[6].

Table 1. Types of Intraoral Scanners

Scanners	Manufacturing Company
Serec Bluecam	Sirona, Bensiam, Germany
Serec omnicam	Sirona, Bensiam, Germany
Cadent iTero	Cadent, USA
Lava cos	3M ESPE, Germany
Trios color	3 Shape, Denmark
E4D	D4D, Texas, USA
Planscan	Planmeca, USA

2. Uses in Pediatric Dentistry

2.1 In the Making of Digital Scanned Impression of the Oral Tissues

The IOS has revolutionized the impression-making procedure in dentistry by making it more comfortable and acceptable to patients, especially young patients[7].

2.2 In the Fabrication of Space Maintainers

Digital 3D intraoral scanners have been employed to capture the replica of the hard and soft tissues of the oral cavity to construct the space maintainers either by CADCAM or 3D printing technology with improved accuracy and ease in digital workflow[8].

2.3 Prosthetic DentistryCleft Lip Cleft Palate Patients

Impression making for fabricating the feeding appliance or obturator in a newborn/infant with Cleft Lip and Palate (CLCP) is considered a cumbersome, risky, and technique-sensitive procedure due to foreign body (impression material) dislodgement (aspiration) or airway obstruction[9].

2.4 For the Expansion of Constricted Maxillary Arch

Zero expanders were reported as a preprogrammed device to expand the narrow dental arch in both deciduous and mixed dentition stages of the pediatric age group. It is a CADCAT digital automatic metal-free fixed appliance[10].

2.5 Rapid Maxillary Expansion

A study done by SánchezRiofrío *et al.* reported a palatal expansion in a pediatric patient with the help of a Cone Beam Computed Tomography (CBCT) scan and CADCAM technology in which a maxillary expander made of titanium grade V, along with two miniscrews and a 3D printed surgical guide was employed[11].

2.6 Myofunctional Appliance

These appliances are used in the pediatric age group with growth potential for the correction of certain malocclusion. Several types of myofunctional appliances manufactured from the conventional technique are used for specific malocclusion in growing patients. Recently, a Functional Regulator of Type 3 (FR3) constructed by CADCAM technology was investigated in the laboratory to analyze certain mechanical properties in comparison to conventional FR3 and in which CAD/CAMmadeFR3 showed superior mechanical properties[12].

2.7 For Para-Functional Habits

Bite splints/occlusal splints are commonly used for parafunctional habits (bruxism), temporomandibular joint-related disorders and also for disharmoniousocclusion problems. In terms of accuracy, both types of CADCAM process, i.e., milled and 3D printed for bite splints are found comparable and to be of equal quality[13].

2.8 For Dental Educational Purposes

3D printed models are available for the simulation of caries to perform pulpotomy and fabrication of stainlesssteel crowns[14].

2.9 In Sports Dentistry

CADCAM/3D printing technology can be utilized for the fabrication of mouthguards in sports. Consequently, such protective gear for sports can be delivered quickly to sports-related people, especially children and adolescents[15].

2.10 Management of Dental and Maxillofacial Trauma

Pediatric patients with oral maxillofacial trauma and accompanied malocclusion require prudent treatment

plans considering that the growth of bones and development of tooth germs should be negatively affected. An article reported that a combination of digital dentistry involving CAD/CAM, and 3D printing in positioning the bite plane for surgical guidance in the treatment of an unstable fracture of the mandible[16].

2.11 Removable Orthodontic Retainers

CADCAM and 3D printing techniques along with CBCT have also been mentioned and described in the literature for making customized removable retainers in orthodontics[17].

3. Advantages of Digital Dentistry in Pediatric Dentistry

3.1 Accuracy/Precision

More accurate as well as less number of clinical and laboratory steps without manual work in processing. Impression materials having inherent shrinkage, and distortion are avoided with such techniques[1,2].

3.2 Comfort to the Patient

No elicitation of gag reflex, no risk of foreign body aspiration, or dislodgment of impression material into the cleft region are some of the advantageous factors for patient safety which are offered using digital impressions using IOS as reported in the existing literature. The digital scanning procedure for the intraoral impression has been reported as more comfortable for pediatric patients and more accepted by the pediatric and their parents/caregivers.

3.3 Faster Processing of Prosthesis/Appliance Fabrication

Owing to the absence of analogic conventional dental impressions, the dental professional can directly send digital STL files to a digital dental laboratory for further processing, leading to digital workflow rapidly[18].

4. Disadvantages of Digital Dentistry in Pediatric Dentistry

- Higher cost of the digital devices and machines: As compared to the analogic workflow (traditional dental procedure).
- Longer learning curve: Specific and advanced knowledge and training is required for dentists to use the IOS and to perform the digital workflow.
- The suitable size of the IOS for scanning inside the oral cavity is another crucial factor, especially for child patients requiring impression-making for dental prostheses/appliances.
- There may be health risks associated with 3D-printed prostheses/appliances because of the uncured resins of monomers or polymers.
- Moreover, a 3D printing machine generates the product through layer-by-layer technology, and thereby in certain conditions it may delaminate under certain stresses or orientations[19].

5. Use of Intraoral Scanner in India

The use of intraoral scanners is limited in India because of multiple reasons such as:

- Training is mandatory to operate IOS because precise and rapid measurements are required while taking an optical impression.
- Visualization of the targeted operating field is important as oral fluid, especially gingival fluid can cause an error in measurement due to optical refraction. Since the device only measures the objects which are confirmed visually.
- While taking Implant-impressions the IOS requires scan bodies, the compatible CAD/CAM system, and the reference software in the implant system.
- At present mandibular position cannot be obtained with IOS which is unchangeable because dynamic occlusion cannot be simulated. Nevertheless, few CAD software's have virtual articulators that mount re-adjustment with jaw-motion parameter[20].

6. Cost of Intraoral Scanner

Normally, 3D intraoral scanner price in India ranges between INR 12 lakh to INR 40 lakh.

7. Conclusion

Pediatric dental procedures involving modern digital technologies such as IOS, CADCAM, and 3D printing

in the applications for the digital intraoral scanned impression-making procedure and in the fabrication of various types of the prosthesis or orthodontics appliances have the good potential to render the optimum dental care in pediatric patients. Furthermore, it can motivate dental patients and can also instil positive and cooperative behaviour and attitude toward dentistry.

However, further clinical research/studies are required to assess the different clinical aspects and factors of digital dentistry involving IOS, CADCAM, and 3D printing in various pediatric dental procedures.

8. Financial support and sponsorship

Nil

9. Conflicts of Interest

There are no conflicts of interest.

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