DIGITALISATION IN PEDIATRIC DENTISTRY

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ABSTRACT
Just like innovation of new materials and technology have revolutionised how oral health practitioners work, technology has also improved the productivity and providing a better experience for patients. Nowadays, dental health practitioners rely on digital tools to control cross-contamination and increase patient safety. This article reviews the scope teledentistry.

KEYWORDS Teledentistry, Oral Mucosal Screening, Computer-Controlled Delivery Of Local Anaesthesia, Influence In Special Care Dentistry, Occlusal Analysis

INTRODUCTION

Nowadays, conventional dental workflow has been replaced by digital dental workflow in several developed countries. The use of digital dental workflow helps in saving time for patients, dental technicians and dentists.

ADVANTAGES AND DISADVANTAGES

Digitalisation has been proven to be advantageous due to the less radiation dose to the patient, it helps in enhancing patient education, generates lesser hazardous waste, instant viewing of image.

However, Infection control of the sensors is often difficult, there are legal concerns with images being altered and initial investment costs.

TELEDENTISTRY

Teledentistry is often correlated with telecommunication and dentistry which involves the exchange of images and clinical information over distances for consultation and treatment planning. Teledentistry has the potential to improve accessibility to healthcare, thereby improving the delivery of oral healthcare, and lowering expenses. It can also minimize the disparities in health care between rural areas and urban communities. Teledentistry uses electronic data to communicate and provide healthcare when distances separate the participants.[1]

DEFINITION

Teledentistry is known as a method of providing dental care or treatment needs through the use of information technology, rather than the use of direct contact with any patient(s) involved. Teledentistry is extremely useful in various branches of dentistry such as preventive dentistry, oral surgery, orthodontics, periodontal conditions, early detection of dental caries, patient education, and diagnosis.

METHODS OF TELECONSULTATION

The consultation process in teledentistry takes place by two means: 'Real-Time Consultation' and 'Store-and Forward Method'

Real-Time Consultation involves a video conference in which dental professionals and their patients, at different locations, may see, hear, and communicate with one another[1]. [2]

Store-and-Forward Method is when the patient is not present to communicate with the dentist and the exchange of clinical information and images collected by the dental practitioner.[5]

Dentists can share patient information, radiographs, therapies applied, lab results, tests, remarks, photographs, and other information transportable through multiple providers.

SCOPE

Teledentistry may turn out to be the cheapest, as well as the fastest, way to bridge the rural-urban health divide. Teledentistry has the potential to eliminate the disparities in oral healthcare between rural and urban communities.[4] It also has the ability to improve access to oral health care, improve the delivery of oral healthcare and lower its costs.[5]

1

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ROLE IN PEDIATRIC AND PREVENTIVE DENTISTRY

Teledentistry has been proven to be useful in helping children with special healthcare needs; as the communication with the dentist can be done at the comfort at their own homes. It is also advantageous in providing dental check-up's for patients who suffer from social anxiety.

ETHICAL AND LEGAL ISSUES

Even though teledentistry has been proven to be advantageous, there have been concerns about the confidentiality of dental information as well as the safety of information that is stored in computers.[5] The practitioners of teledentistry should be extremely cautious that patient privacy is not compromised by unauthorized entities. [4] In teledentistry practice, medicolegal and copyright issues also have to be considered. These problems arise primarily due to a lack of well-defined standards.[6]

ORAL MUCOSAL SCREENING

Globally, oral cancers account for 2.1% of all cancers [7]. They are malignant tumors that are directly visible, but it is difficult to differentiate and diagnose because of the existence of many oral potentially malignant disorders (OPMD), precancerous lesions, and precancerous conditions in the oral mucosa.

Introduction of non-invasive autofluorescent imaging has been useful for screening of the oral mucosa. [8]. The presence of certain fluorescent substances within the oral epithelium and submucosa fluoresce with a blue excitation (400-460 nm) light source. Oral lesions can be observed through direct fluorescence visualization (FV). FAD and CCL tend decrease with the progression of the epithelial dysplasia present in SCC and OPMD, resulting in fluorescence visualization loss (FVL), which appears as a dark area on the image. In healthy areas, the blue excitation light source stimulates the emission of green light from endogenous fluorescent substances [10].

Optical instruments with fluorescent light, such as the VELscope (LED Dental, White Rock, British Columbia, Canada) and narrow band imaging (NBI; Olympus Corporation, Tokyo, Japan) have been recently used as non-invasive early screening methods [8]. The IllumiScan (Shofu, Kyoto, Japan) is an alternative which has a light body and can take FV images followed by which the data can be saved in the digital camera. IllumiScan can be used to scan the keratinized mucosa, which is not available for IOM. Moreover, this device is compact, convenient to carry, and can be viewed and saved in real time. To our knowledge, there is no study that describes IllumiScan in English to date.

COMPUTER-CONTROLLED PLAQUE REMOVAL TOOTHBRUSHES

The electric toothbrush has gained popularity over the years due to its ease of use and superior plaque removal and gingival health improvements for certain models compared to manual brushes[11-14].

In these toothbrushes, the O-R movements disrupt and remove plaque via rapid shearing forces while the round brush head maximizes access in hard-to-reach areas. The Oral-B iO toothbrush has customizable interactive features via 'Smart' technology for real-time feedback and coaching linking a mobile app and the brush to monitor brushing habits [12]. This toothbrush has been proven to be advantageous due to, a linear magnetic drive, which delivers clinically-proven O-R technology, along with micro-vibrations resulting from controlled energy being directed to the bristle tips. This brush is also extremely quiet, which is favoured by the users. This toothbrush also augments brushing feedback with a 'smart' pressure sensor which guides the user to brush in the optimal pressure range of 0.8–2.5 Newtons (N). This range was determined via previously conducted laboratory robot testing of plaque removal effectiveness across a range of pressures. [15-18] The sensor light present on the toothbrush also changes color based on brushing force, thereby coaching the brusher to maintain consistent pressure in the ideal window via positive reinforcement. A green light provides a positive feedback indicating the most favorable brushing pressure (0.8–2.5 N) for plaque and a red light indicates there is too much force (>2.5 N). The user can also have an interactive experience for guidance in a 2-minute brushing session with 3D teeth tracking, via a compatible Oral-B iO app with Bluetooth connectivity, without having to bring their Smartphone into the bathroom or mount it on the mirror.

COMPUTER-CONTROLLED DELIVERY OF LOCAL ANAESTHESIA AND NITROUS OXIDE

Dental fear is one of the most common reasons for pediatric patients to avoid visiting the dentist. Dental fear can be caused due to a variety of reasons such as the noise and vibration from tooth-cutting devices the smell of dental materials and pain that might be present during dental treatment. [19] Because dental treatments may be painful, appropriate local anesthesia is necessary to reduce pain. However, contrarilly, patients often fear pain caused by anesthetic injections more than pain from dental treatment itself [20]. Pain casued during injecting local anesthesia can be caused due to a variety of reasons, including soft tissue damage during penetration of the oral mucosa, pressure from the spread of the anesthetic solution, temperature of anesthetic solution and low pH of anesthetic solution. To reduce pain caused during local anesthesia, swabbing anesthesia is often performed on the injection point. The dentist should also be cautious that the anesthetic ampoule must be used administered at a temperature similar to body temperature, administration of the drug should be doen slowly and sterile local anesthesia should be used [21]. Although reducing the injection speed is the most effective method of reducing pain, controlling and maintaining the amount or speed of injection in actual clinical settings is difficult. Many comuterised devices have been introduced that can inject local anesthetic into the tissues at a set speed which are referred to as, "painless anesthetic devices" and "computer-controlled local anesthetic delivery" (CCLAD) devices. The most widely known devices of this type include the Wand® (Milestone Scientific, Livingstone, NJ), Comfort Control Syringe (CCS; Dentsply, USA), QuickSleeper (Dental HiTec, France), and iCT (Dentium, Seoul, Korea)

CCLAD can reduce pain perception by controlling the injection speed, which can thereby reduce the resistance felt in the tissues, which eases the application of the anaesthetic solution.

Milestone Scientific (Piscataway, NJ, USA) introduced the Wand® in 1997 and ever since then companies have been developing newer systems such as, the Comfort-in® , Deninjection® Quicksleeper® and Comfort Control Syringe (CCS®).

INFLUENCE IN SPECIAL CARE DENTISTRY

The incorporation of dental equipment and technology by dentl professionals can help provide apt treatment for children with special healthcare needs.

NON-INVASIVE CARIES DETECTION TOOLS

Diagnosis can be defined as the art and science, which help in the synthesis of clinical experiences and scientific knowledge in identifying the signs and symptoms of a particular disease.

According to Shafer (1993), Dental caries can be defined as the process of progressive demineralization of inorganic component of the tooth accompanied by disintegration of the organic portion.[22] It is an extremely dynamic disease process, where initial lesions undergo cycles of demineralisation and remineralisation before being expressed clinically.

Therefore, it is extremely important to recognise the initiation of caries rather than searching for newer cavities. Accurate diagnosis would aid in preventive treatment such as fluorides and pit and fissure sealants, which can improve the dental health of the child, thereby reducing the need for further dental treatment.

An ideal diagnostic tool should be able to detect dental caries at its earliest stage possible and provide valid caries risk assessments for age groups.

Advanced methods of caries detection can be either by the use of digital radiographic methods and by the use of visual light optics. Digital radiographic methods include digital image enhancement, digital subtraction radiography and tuned-aperture computed tomography (TACT). Digital imaging is created by a spatially distributed set of discrete sensors and pixels. There are two types: Direct digital imaging, where the direct image receptor that collects X-ray directly, such as the RVG, Indirect digital imaging is when a video camera can be used for forming digital images of a radiograph. The digital detectors include, charged couple device (CCD) , complementary metal oxide semiconductor and Photo Stimulable Phosphor plate (PSP).

Visible light caries detection methods include, digital Image fiber-optic transillumination, optical caries monitor, quantitative fiber-optic transillumination and quantitative light/laser-induced fluorescence (QLF). Laser light caries detection methods include, DIAGNOdent – Laser autofluorescence. Electrical current caries detection methods include, electrical conductance measurement and electrical impedance measurement. Ultrasound caries detection methods include, Ultrasonic caries detector.

Visible Light Optical caries monitor is used to detect white spot carious lesions. Light is transported through a fiber bundle to the tip of handpiece. The tip is placed against the tooth surface and reflected light is collected by different fibers of the same tip.[23]

Digital imaging fiber-optic transillumination (DIFOTI) was to elevate traditional transillumination to a higher diagnostic levels. DIFOTI uses safe white light from which images are taken whch are digitally captured using a digital CCD and sent to a computer for analysis. The receptor present helps convert photon energy to electrical energy and the image can be viewed on video monitor. When the teeth are illuminated, incipient caries present appear to be darker compared to mineralised enamel or dentin. Images taken during different clinical stages can be assessed over time.[24] This system consists of a measurement probe, control unit, and computer fitted with a frame grabber. The light source from the control unit is the special arc lamp based on xenon technology. The light from this lamp is filtered by a blue-transmitting filter. This light guide transports blue light to the teeth. Recording of the image is done with a yellow transmitting filter positioned in front of the color CCD sensor. The image is then digitalised and is available for quantitative analysis. The tooth seen on a computer monitor can be visualised as a fluorescent green and dark area, which indicate mineral loss or white spot lesions. The presence of a red fluorescence indicates leaking around restorations and sealants. This is emitted by porphyrins metabolized by bacteria in dental biofilm, calculus, or an infective carious lesion and usually indicates a high caries activity. [25]

Laser Light DIAGNOdent was introduced in 1998 to diagnose occlusal caries along wth visual and radiographic examination. It uses infrared laser fluorescence of 655 nm to detect of occlusal and smooth surface caries.[26]

DIAGNOdent pen is an advancement which is useful in detecting fissure and smooth surface caries accurately.

Electrical conductance measurement (ECM) works on the principle that more pores are seen in demineralized teeth which are filled with water or saliva. [27] The mode of application is site-specific, where the probe is applied into fissures and the electrical conductance of that site is measured. In order to prevent the current from leaking through superficial layer of moisture continuous airflow should be applied to dry the tooth surface around the probe. Disadvantage is that only small areas of occlusal surface can be measured at one time.

Caries meter uses a current of 400 Hz. The measured conductance is then converted to four colored lights., namely, green which indicates the absence of caries, yellow, which indicates slight enamel caries, orange, indicating dentin caries and red which indicates pulpal involvement. This method requires pits and fissures to be moistened with saline.

Electrical impedance measurement is an assessment of the degree at which an electric circuit can resist electric current flow when voltage is applied across two electrodes.

Further advancements include, Multiphoton imaging [28,29], Infrared fluorescence[28,30], Infrared thermography[31,32], Terahertz imaging[32], Optical coherence tomography[32], Polarized Raman spectroscopy[32,33] and Modulated (frequency-domain) infrared photothermal radiometry.[34]

RESTORATIVE DENTISTRY WITH CAD-CAM

There is a great variation in the oral environment, the health of the patient and the treatment requirements [35]. There is a great variation in the rate and type of abrasion for the teeth of different individuals.

It is important to choose the right restorative material in order to keep the normal function and the masticatory harmony. Gold alloys are generally considered to the the best restorative material because of their durability and cause a minimal abrasion of the antagonist's natural enamel. An alternative to gold alloys can also be ceramic due to the aesthetics. However, the they have a high rate of abrasion caused by the opposing tooth.[36] Over the past few years, ceramic restorations produced by Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) have significantly raised their quality. Several modifications in the digital impressions, cutting technique and software design, have yielded excellent clinical results. Proper marginal design, patient selection and the retraction of the tissues are important factors that must be kept in mind. [37,38] CAD/CAM technology helps in reducing clinical time in the dental office and faster production of the restoration thereby providing excellent aesthetic result. [39,40] However, CAD/CAM restorations are expensive and special education needs to be provided to the dentist who works with the CAD/CAM system. [39] In children, careful assessment should be done with retained primary teeth. After consideration of general issues, such as the patient's health, motivation, expectations and oral health, a local assessment should be made. Clinically dentists should focus on the coronal shape, colour and structural integrity of the primary teeth [41]. In cases where root and crown structure of the tooth are good but infraocclusion has occurred and there is a need of aesthetic improvement, the primary tooth may be reshaped. The easiest approach is by using direct composite.

CONCLUSION

With the developments that take place in the field of teledentistry, practitioners may link up to virtual dental health clinics and a new era of dentistry can be created. There might be a time where there is telemedical control of robotized instruments in situations with long-term unavailability of dental care.

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