PORTABLE ELECTRONIC TOOTH SCALER WITH INTRAORAL CAMERA AND ANTI BACTERIAL TREATMENT FACILITY

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ABSTRACT

This research work relates generally to an electronic dental instruments and more particularly, to tooth scalers having a vibrating scaling tip. The most abundantly available portable tooth scalers in the market are generally cheap & low quality products whose vibration intensities are not at par with that desired by the dentists to do the job satisfactorily and hence plaque removal becomes difficult especially in remote areas where the highly sophisticated dental chair cannot be set up.

This research aims at modifying the design of these unserviceable low quality dental scalers so as to enhance their usability. It aims to increase the vibration intensity of the scaling tip so that plaque removal becomes easier. The designed modified apparatus consists of a lower main body and two removable upper parts - one consisting of the dental scaler, and the other 3D printed detachable upper part consisting of a 470 nm blue LED [3] and an intraoral camera. Controls are provided to increase and decrease the intensity of the vibrating scaler. The proposed modified dental scaler can be conveniently used to treat patients at remote locations without using bulky scaling setup as well as other dental instruments, such as intraoral dental mirror .

Keyword: - *Dental scaler, intraoral camera, portable device and dental mirror*

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1. INTRODUCTION

Antibiotic resistance of microbes is a quickly growing and extremely dangerous health threat. It is now indisputable that antibiotic resistance is life-threatening in the same sense as cancer, both in the number of cases and the likely outcomes. Maintaining healthy teeth and gums is a lifelong commitment. The earlier you learn proper oral hygiene habits - such as brushing, flossing, and limiting your sugar intake - the easier it'll be to avoid costly dental procedures and long-term health issues. Dental cavities and gum disease are very common. According to the World Health Organization - between 60 and 90 percent of school children have at least one dental cavity, nearly 100 percent of adults have at least one dental cavity, between 15 and 20 percent of adults ages 35 to 44 have severe gum disease, about 30 percent of people around the world ages 65 to 74 don't have any natural teeth left and in most countries, out of every 100,000 people, there are between 1 and 10 cases of oral cancer. The burden of oral disease is much higher in poor or disadvantaged population groups.

The distribution of dental manpower between rural and urban areas reflects a glaring contrast. About 80% of dentists work in major cities catering to the oral health needs of around 31% of urban population. In rural India, one dentist is serving over a population of 250,000. Alternate modes of providing dental services other than traditional dental clinics and private hospitals should be implemented to overcome the present discrepancy in the delivery of oral health care between rural and urban population with special emphasis on covering the underserved population. Mobile and portable dental services may offer a viable option to address the issues of oral health-care delivery for an extensive underserved population in a developing country like India with scarce resources.

Portable dental units can be of advantage in places like naturally isolated areas such as high altitudes or dense forests, military and missionary programs, or disaster situations where mobile dental units cannot be transported. Portable systems are smaller and more compartmentalized as compared to mobile vehicle systems. They can be transported easily, are time efficient, and relatively require less equipment.

1.1 Dental Scaler

A Conventional Hand-held Scaler is a tool that dentist use to scrape stains, plaque, and tartar from the surface of the teeth. It's a metal tip hand-held tool with an end shaped like a curved or hooked blade. These metal tools have sharp cutting edges that dental hygienists use to remove plaque and tartar from teeth.These depend on the skill and knowledge of the hygienist to manipulate them and scrape away calculus (tartar) from teeth and within pockets. They take longer to complete a cleaning. Sometimes they cause more discomfort than ultrasonic scalers.
Removing plaque is important. When plaque is allowed to build up on the teeth, it can cause problems like gum disease and tooth decay.

The electronics scalers use the energy of tip vibration to crush and remove hard, calcified deposits of calculus. They also create shockwaves that disrupt bacterial cells. Use of these tools include washing and flushing the pockets and any exposed root surfaces with water.

1.2 Treatment of Bacterial Microorganisms

Bacteria contain a black pigment that is sensitive to light, especially visible light in the blue spectrum. When activated by blue light, a reaction is induced that kills the bacterial microorganisms within seconds. Blue light technology is scientifically proven to kill harmful oral bacteria. As many as 700 different types of oral bacteria are found in the dental plaque that accumulates on our teeth. When the proportion of harmful bacteria is reduced, the share of beneficial bacteria increases which helps defend against harmful microbes. Along with treatment of oral bacteria blue light technology provides with the advantage of polymerization of resin based composites (Filling).

Dentists initially used halogen lamps for curing in which, up to 70% of the input power is converted to heat, with only 10% resulting in visible light. Of this visible light, a further 90% is lost due to the use of cut-off filters. Ultimately, their blue light output makes up only 1% of the total energy input [2]. Also it can be cumbersome to carry it to remote areas due to their size. It is envisioned that microbes are less able to develop resistance to antimicrobial blue light than to traditional antibiotics, because of the multi-target characteristics of antimicrobial blue light.
In addition, it is well accepted that antimicrobial blue light is much less detrimental to host cells than UVC irradiation.

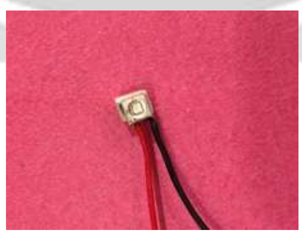

Fig -5 : Blue LED

1.3 Intraoral Camera

For years, dentist have used dental mirrors for insertion in the dental patients mouth for reflecting images of areas within the patients mouth for viewing by the dentists. This technique works, although it has several disadvantages.

First, it is often difficult to hold the dental mirror in an appropriate position in order to reflect the desired image. Secondly it is more difficult to ensure that proper lightning is available to the area within the mouth to be reflected by the dental mirror. An even greater disadvantage is that it is very difficult to use such prior art dental mirror in a situation where a dentist wish to discuss certain regions within the mouth with other people, be it the patient, colleagues, dental assistance or student in a teaching institution.

In different areas of medicine, particularly in gastroenterology, endoscopes had been used for many years. The potential of miniature intraoral cameras improved as manufacturers improved them. While the images are not considered diagnostic, they play a role to augment and enhance diagnoses when paired with other diagnostic measures like radiographs.

People often fear a dental treatment and are unaware of the problems in their dental structure. Dental cameras can enable patients to understand the problems and support the dentist throughout the action plan of treatment. Dental cameras are not superior tools like radiographs but do succeed in providing a magnified, clear close-up at the current conditions. Patients can participate directly in the decision making process as far as preferred treatment is considered.

Just a tad longer than the size of a pen, an intraoral camera has a tiny lens fitted on its tip. The intraoral camera is connected to the dentist’s computer and when it is moved around inside the mouth, it captures images that can be transmitted to the computer and can be seen by both, the patient and the dentist.

The latest-technology intraoral cameras allow a dentist to freeze the shots he desires and examine them in-depth. These captured images can be arranged, enlarged, and stored for better diagnosis and future records.

Fig -1: Intraoral Camera

2. EXISTING PORTABLE TOOTH SCALER

The existing portable tooth scaler available in the market is dominated by Chinese product consisting solely of a scaling tip. The vibration intensity of these are not at par with that desired by the dentists to do the job satisfactorily. Vibrations are generated by a coreless brushless DC motor (BLDC).

Fig -2: Internal configuration of scaler

The concept behind generation of vibration by a DC motor is an unbalanced weight (10gm) added at the tip/axle of the of the motor. This off-centered weight attached to the motor's rotational shaft causes the motor to wobble. The amount of wobble is changed by the amount of weight that you attach, the weight's distance from the shaft, and the speed at which the motor spins. These vibrations from the motor's body are transferred to the scaling tip using a mechanical arrangement/structure. Motor's body is firmly attached to this mechanical arrangement.

Fig -3: Internal Components of scaler

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The existing portable tooth scaler uses a rechargeable lithium ion battery as a power source.

Clearly, it cannot be used for multi-purposes such as for taking pictures of affected tooth and also does not have a provision for antibacterial blue light therapy which arises the need to carry cumbersome apparatuses with huge setup to remote area dental visits and camps.

2.2 Proposed Modifications

This project aims at modifying the architecture of the current in-use portable electronic tooth scalers used by the dentists.

It aims to modify the current design so as to get a scaler capable of vibrating at higher intensities.

Further, blue LEDs having peak wavelength of 470 nm which possess antibacterial properties have also been added so as to facilitate the healing process. The wavelength of the LED was tested and verified using diffraction grating experiment.

Along with this, a camera is also added so that diagnosis becomes easier and accurate. The camera used is a type C endoscope waterproof IP67 snake tube inspection camera with 8 LEDs and a USB adapter. The LED and the camera are mounted on a separately 3D printed upper neck model.

3. OBSERVATION

In order to increase the motor speed, a brushless DC motor with higher RPM is used. The motor is skillfully placed inside the contrivance with selection of proper shaft weight. It has been observed that a 7*16 mm BLDC motor help to increase the rpm of the vibrating tip when measured with the help of a contactless tachometer.

Voltage (in Volts)	Rpm of initial motor	Rpm of new motor
3	6000	11000

3.5	7700	15000
3.7	8200	19000
5	9700	32000

Table 1: Relationship between voltage applied to the motor and the motor RPM.

As observed from Chart.1, with the help of the 7*16 mm BLDC motor, the rpm of the scaling tip became twice of what it was initially

An unbalanced weight added to the shaft help to increase the vibration intensity of the scaling tip by introducing a damping effect. The increase in intensity is directly proportional to the weight of the unbalanced weight and inversely proportional to the distance of the unbalanced weight from the motor.

Side	Main Scale Reading	Vernier Scale Reading	Total Reading (Degrees)
LHS1	143.5	1	143.516
LHS2	142	4	142.066
RHS1	175.5	20	175.533
RHS2	178.5	5	178.583

Table 2: Observations from Diffraction Grating Experiment

The equation for wavelength of light using diffraction grating is,

$n\lambda = dsin\vartheta$, where mode n=1 and distance between adjacent slits, d= 1.6933 x 10-6

2ϑ= RHS1-LHS1

$\vartheta = 16.0085$

λ =466.978 nm

Hence, it can be observed that the LED requirements match the desired requirements within experimental limits.

The diffracted spectrum is shown in figure 3.

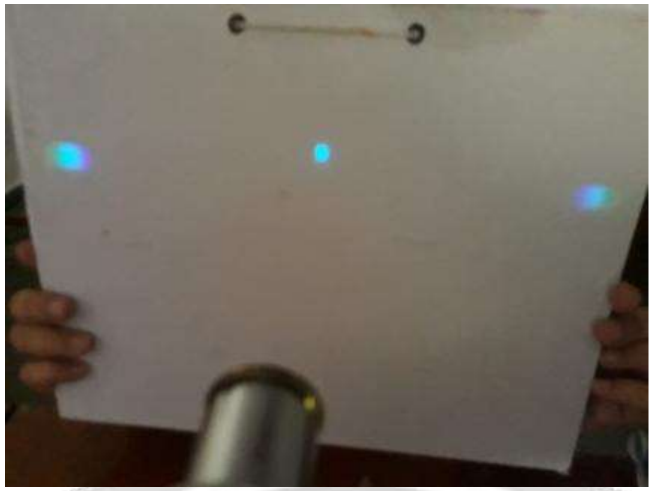

Fig -3: Diffraction of light emitted from LED

The 470 nm blue LED is fabricated into a 3D printed model of the detachable neck along with an endoscopic camera to get images of the oral cavity.

A 3.7 volts coin cell is attached at the bottom of the main body to power the LED.

4. CONCLUSION

This research presented in this paper relates to modification and performance improvement of existing dental scalers, having a vibrating scaling tip. The vibration intensity of existing scalers is poor hence seldomly used by dentist for oral treatment. As the plaque removal with such scalers is difficult so it lacks its very purpose of use in remote areas, where the highly sophisticated dental chair cannot be set up.

This research work aims at modifying the design of these unserviceable low quality dental scalers so as to enhance their usability. The designed modified apparatus consists of a lower main body and two removable upper parts - one consisting of the dental scaler, and the other 3D printed detachable upper part consisting of a 470 nm blue LED and an intraoral camera. The modifications are made in the existing scalers by choosing appropriate high RPM motor with proper balancing weights. Also the design of motor housing has been modified that facilitate enhanced vibrations thereby enhancing the utilization of apparatus under consideration.

The existing dental scalers are used only for scaling purpose. The proposed modified scaler has additional detachable neck that embraces blue LED and an intraoral camera. Thus the proposed modified dental scaler can be conveniently used to treat patients at remote locations without using bulky scaling setup as well as other dental instruments.

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