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Systematic Review

Use of Digital Scanning in Measuring the Keratinized Tissue Width Instead of Periodontal Proble - A Systematic Review

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Abstract

When it comes to the periodontal pocket, one of the absolute signs of periodontal disease, is the most common parameter to be assessed by dentists. Periodontal probes are usually the instruments most commonly used in measuring the pockets. The target of this research is to evaluate researches done on the progress of periodontal probes in measuring the pocket depths. In this systematic review, a total of 100 articles from 1973 till 2019 in pubmed and ovid medline only were collected, the articles related to the subject of evaluating the pocket depth. The periodontal pocket is one of the absolute signs of periodontal disease, is the most common parameter to be measured by dentist. One of the more definitive and repeatable ways of detecting, measuring, and assessing the progress of the periodontal disease activity is through the use of periodontal probes. Numerous periodontal probes supply to different needs. The needs of a general dental practitioners are different from those of a specialist periodontist who normally requires a more specialized set of periodontal probes. Universities and Research institutes can effectively use more complex periodontal probes. Also, because the latest generations of periodontal probes work on dependence of computers, the digital dentistry in a dental practice has to be considered during the selection procedure. There are five generations of probes currently in the market from the most basic to fully automated digital reading probes. After evaluating latest developments in the field of periodontal probing, it provide the potential for error-free checking of pocket depth and clinical attachment level at every possible stage. But at this moment we still need further studies in this field to achieve an error free pocket depth readings digitally.

Keywords: *Periodontal Pocket; Periodontal Probes*

Introduction

When it comes to the periodontal pocket, one of the absolute signs of periodontal disease, is the most common parameter to be assessed by dentists [1]. Periodontal probes are usually the instruments most commonly used in measuring the pockets. Regular use of periodontal probes in dental clinics facilitates and increases the precision of the process of diagnosing the condition, formulating the treatment planning, and predicting the outcome of dental therapy [2]. Improvements in the field of pocket depth probing have led to the development of probes that can certainly help reduce the errors in determining this parameter used to define the state of active periodontal disease. One such advancement is the emergence of periodontal probes that assess periodontal disease activity noninvasively. Deepened periodontal pockets applies a significant pathological burden on the host and its immune system, more severely in a patient with generalized moderate to severe periodontitis [3]. The selection of a periodontal probe depends on the type of dental clinic as general dentist would require first- or second-generation probes, while third- through fifth-generation probes generally are used in academic and research institutions as well as specialty dental practices [4].

Materials and Methods

In this systematic review, a total of 100 articles from 1973 till 2019 in pubmed and ovid medline only were collected, the articles related to the subject of evaluating the pocket depth. The periodontal pocket is one of the absolute signs of periodontal disease, is the most common parameter to be measured by dentist. One of the more definitive and repeatable ways of detecting, measuring, and assessing the progress of the periodontal disease activity is through the use of periodontal probes. Periodontal probing permits dental practitioners to identify location with a history of periodontal disease. As it has been described by Orban that the eye of the operator beneath the gingival margin, periodontal probes are an essential part of a complete dental inspection.

Numerous periodontal probes supply to different needs [5,6]. The needs of a general dental practitioners are different from those of a specialist periodontist who normally requires a more specialized set of periodontal probes. Universities and Research institutes can effectively use more complex periodontal probes. Also, because the latest generations of periodontal probes work on dependence of computers, the digital dentistry in a dental practice has to be considered during the selection procedure [7-9].

Discussion

Periodontal probe generations

The American dentist John M. Riggs (1811 - 1885) investigated diseases of the gingiva extensively and in 1867 postulated that they could be treated effectively. Riggs offered his patients a form of non-surgical therapy which consisted of a very thorough subgingival curettage to eliminate diseased tissue and calculus that had accumulated on the root surfaces. To remove calculus, he used a set of six scaler-like instruments. Riggs obtained excellent results, and in recognition of his outstanding accomplishments, alveolar pyorrhea was renamed "Riggs disease". Riggs' therapy was applied by other dentists, especially D.D. Smith and W.Y. Younger in Europe. Today, Riggs, Smith, and Younger are considered the pioneers of conservative periodontal therapy. They faced opposition from a small group of specialists who clearly favored the surgical approach. However, Riggs vehemently disapproved of periodontal surgery and described it as being of barbaric origin [10,11]. Until Riggs, there was no description of a periodontal probe in the literature. By and large, alveolar pyorrhea was diagnosed based on suppuration and increased tooth mobility. University of Michigan has probe with the name of O probes which has markings at 3 mm, 6 mm, and 8 mm [12-14].

University of North Carolina (UNC-15) has another set of probes which are color coded at every millimeter distinction. They are the usually used probes in dental clinical research if conventional probes are required [15]. The Nabers probe is used in measuring the involvement of furcations by the periodontal disease process in multi-rooted teeth. Nabers probe also is used in the assessment of more complex clinical cases, including those with a prosthodontics and operative dentistry treatment. These probes can be color-coded or without demarcation [16].

Second-generation

(Constant-Pressure) Probes Probing of periodontal pockets has long been accepted as the gold standard for the determination of periodontal conditions. Earlier, Waerhaug (1952) had suggested that pockets should be assessed using "light hand pressure". He had estimated that probing pressure, as measured at the probe tip, should not exceed 0. 2 N/mm^2. Schmid (1967) investigated 48 pockets exhibiting an average depth of 4.6 ± 1.9 mm in three subjects with adult periodontitis and found that a probing force of, on average, 0.226N was sufficient to guide the flat plastic tip of the Plast-O-Probe into the cleft of a periodontal pocket. In comparison, an average force of 0.363 N was applied by the examiner using the ZIS periodontal probe to inspect the same pockets. In these experiments, the instrument used

Techniques for periodontal pocket examination	Advantages	Disadvantages	Studies performed on periodontal pocket examination
Periodontal pocket CBCT-based examination using radio-opaque contrast agents	• High resolution • Lower radiation exposure • Fast scanning • Broad application • CBCT widely available and routinely used	• Ionizing radiation • Metallic image artifacts	• Weidmann., *et al*. • Velea., *et al*. • Elashiry., *et al*. • Elashiry., *et al*.
Optical coherent tomography	• Non-ionizing radiation • High tissue contrast • High resolution	Deep tissue imaging limited by light waves scattering	• Mota., *et al*. • Fernandes., *et al*. • Kim., *et al*. • Kakizaki., *et al*.
Photoacoustic imaging tomography	• Non-ionizing radiation • High resolution deep tissue imaging vs OCT • Higher contrast vs ultrasound imaging • Faster scanning vs MRI	• ~5 cm tissue penetration • Poor penetration of gas cavities • Thick bones attenuate and distort signals	• Lin., *et al*.
Endoscopic capillaroscopy	• Non-ionizing radiation • Image pocket through microcirculation	• Not clear if pocket depths, area or volumes possible	• Townsend nd D'Aiuto • Townsend., *et al*.
MRI	• Non-ionizing radiation • Soft and hard tissue imaging with short echo time MRI generations	• Only soft tissue imaging and low resolution with conventional MRI • Long scanning time • Short echo time MRI systems not broadly available for clinical MRI or routine dental imaging • Not clear if new MRI can image periodontal pockets	N/A

to measure force consisted of a dynamometer with the probe tip attached to the end of the lever arm [18]. This probe was not suitable for full-mouth examination. Probing forces were transferred from the tip to the sensor via a piston arrangement, and the electric potential generated in the piezo element was amplified, stored on tape, or converted into a printer signal. Eight experienced dental clinicians independently examined eleven young adults with healthy gingiva [19]. Probing force, depths and bleeding upon probing was recorded. Average force per dental examiner ranged from 0.198 ± 0.074N to 0.320 ± 0.121N. The data did not suggest a cause-and effect relationship between force applied and occurrence of bleeding in healthy subjects. In a subsequent experiment that included six clinicians, Hassell., *et al.* examined five subjects exhibiting different degrees of severity of adult periodontitis. Using the same pressure sensitive periodontal probe as in the previous study, they found a wide range of probing forces, varying, on average, from 0.235N to 1.127N [20]. These findings and a series of investigations that identified a positive correlation between probing force and depth of probe penetration led to the construction of probes with constant probing force. Armitage., *et al.* investigated the accuracy of clinical attachment levels using a pressure-sensitive probe holder. It was made from a 16-gauge transparent catheter around a needle, a needle shaft, and a spring that was placed around the needle shaft. The needle shaft could be moved into the catheter. The extent of insertion was examined by the force of the spring. The instrument which was calibrated for forces from 0.15N to 0.35N in 0.05-N increments. Any kind of periodontal probe tip could be attached to the needle shaft. In their study, Armitage., *et al*. used a probing force of 0.25 N and a Michigan '1' probe tip with a terminal diameter of 0.38 mm which resulted in a probing pressure of 2.20 N/mm^2 [21].

Third-generation probes (Automated probes)

Regardless of the advances in the second-generation probes, other errors, such as in reading the probe, recording data, and calculating attachment level, still needed to be addressed. Third-generation probes were created to decrease these mistakes by using the standardized pressure, and also to digitalize the readouts of the probes readings and computer storage of data. This generation includes digitally-assisted computer data capture to reduce examiner bias and allows for better probe precision [22].

Foster-Miller probe is by detection of the CEJ which is a third generation periodontal probe. The ball tip slides over the root surface at a controlled speed and preset pressure [23,24]. Sudden changes in the speed of the probe movement indicates when it meets the CEJ and when it is stopped at the base of the pocket [25,26]. The main advantage is the automatic and accurate detection of the CEJ, which serves as better reference than gingival margin, because the position of the gingival margin may change depending on inflammation or recession. The main drawback is that it can deem root roughness or root surface irregularities as the CEJ [27,28].

These probes provide a constant probing pressure of 15 gm, which can be overridden when necessary, for accuracy and patient comfort. They also can record missing teeth, recession, pocket depth, bleeding, mobility, and plaque assessment [19]. Each evaluation is recorded with potentially 0.2-mm accuracy. Comparison to previous data can be made more quickly and accurately. (The system shows black arrows for changes between 1 mm and 2 mm, and red arrows are used for changes > 2 mm) [29]. The Florida Probe does have some disadvantages, which include underestimating deep probing depths a lack of tactile sensitivity. Also, dentists need to be trained to operate these periodontal probes [30].

In the University of Toronto during 1991 they devised Toronto automated probes that used the occlusoincisal surface to measure relative clinical attachment levels [31]. The depth of the sulcus is probed with a 0.5-mm of ni-ti wire that is extended under air control pressure. It controls angular mismatch by means of a mercury tilt sensor that limits angulation within [32]. This probe has the advantage of an incorporated digital guidance system to improve precision in probe angulation. The drawback was related to the positioning: it is really hard to examine the posterior teeth, and patients have severe difficulty to position their heads in the same place to reproduce readings.

Fourth-generation probes

This technique of periodontal diagnosis by ultrasonic probes involves projection of an arrow ultrasonic beam with high frequency to the periodontal pockets. The echoes of the ultrasound wave reflected by the crest of the periodontal ligament are recorded by a transducer located inside the probe hand piece then transmitted to computer software for analysis. The ultrasonic image is digitally created and the software translates the data to estimate the pocket depth measurements. In addition to that, there is another disadvantage which is the high price and the poor contrast of ultrasonography. Moreover, the feasibility of these techniques to provide 3-D information about the disease has not been established [7].

Fifth-generation probes

Fifth generation probes are the ultra-sonographic probe system. Its constituents includes contra angled hand piece, digital computer electron box for water control, foot pedal, transducer emits and receive sound waves. The only fifth-generation probe available, the Ultra-Sonographic (US) probe (Visual Programs, Inc, Glen Allen, VA), uses ultrasound waves to detect, photo, and create the upper boundary of the periodontal ligament and its variation over time as an indicator of the presence of periodontal disease [24]. To probe the periodontal ligaments ultrasonically, a narrow beam of ultrasonic energy is projected down between the tooth and the bone from a transducer, which is scanned manually along the pocket depth [32].

Conclusion

After evaluating latest developments in the field of periodontal probing, it provide the potential for error-free checking of pocket depth and clinical attachment level at every possible stage. An automated periodontal probe offers itself as an effective method tool in collecting probing pocket depths. An automated probing system saves time in evaluating periodontal pockets depths and provides immediate recording and analysis of different indicators of periodontal health condition. We still need further studies in this field to achieve an error free pocket depth readings digitally.

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