

**Sensitivity and Specificity of Selected Methods for
Diagnosing Early Carious Changes**

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AIM OF THIS STUDY

The main aim of this study was determining the sensitivity and specificity of chosen diagnosing methods for early caries lesions detection on the occlusal surfaces of molars in relation to the development of changes validated histologically.

The additional aims are:

1. determining the sensitivity of the used methods (visual evaluation, fluorescence measurement using the Diagnodent laser device, conventional X-ray study, radiological study using the Digora system and using four ac impedance spectroscopy parameters – dc resistance R_b , high frequency resistance R_s , capacitance parameter T and phase angle φ) in relation to carious changes within enamel and dentine,
2. evaluating diagnostic accuracy of individual methods expressed by Youden coefficient and
3. determining correlation between the used methods.

SUMMARY

It is optimal for the health of oral cavity to prevent caries development by assessing the risk of its incidence and using appropriate prophylactic methods. If such methods were not used or despite of using them, the carious process has developed, it is crucial to detect the changes in the initial, reversible stage when there is no need for restoration and non-invasive procedure can be chosen, i.e. lesion remineralisation.

The aim of the study was to evaluate sensitivity and specificity of the selected diagnostic methods of early caries detection on molars occlusal surfaces validated in a histological examination. The studied material consisted of 48 extracted un-restored third molars extracted from subjects aged 23-35. Occlusal surfaces of the studied teeth were examined by: (1) naked eye, (2) the Diagnodent laser device (wet and dry surfaces), (3) conventional X-ray examination, (4) radiological study using the Digora system, (5) ac impedance spectroscopy – values of 4 equivalent circuit parameters were analysed: direct current resistance R_b , capacitance parameter T , phase angle φ and resistance at high

frequencies R_s (an Autolab 30 Analyser, range of ac frequency 0.1-400 kHz), (6) histological study in a light microscope (Olimpus BX 50) connected to computer analysis system – Multiscan Base software version 08.98. The studies were carried out by two researchers independently. The Diagnodent laser device study and ac impedance spectroscopy measurements were repeated after a fortnight.

The obtained results were analysed by Wilcoxon test, U Mann-Whitney test, κ (kappa) coefficient, Youden coefficient and a coefficient of Pearson correlation. In addition, ROC curves were plotted and discriminating values were determined. Thorough analysis of the ac impedance parameters demonstrated that low frequency resistance R_b is not useful for differentiation of tissue state as the range of values for caries-free teeth overlapped with that for teeth with carious lesions and a discriminating value was not found.

The attained data showed high reproducibility of the results (coefficient κ) obtained by two researchers as well as in two studies by the same researcher applying presence/absence of change criterion. The coefficient κ was equal to 1 for visual evaluation, 1 for the Diagnodent study on both the wet and the dry surfaces, 0.72 for conventional X-ray, 0.83 for radiological study using the Digora system, 0.86 for phase angle φ , 0.81 for low frequency resistance R_b , 0.75 for capacitance parameter T , 0.67 for high frequency resistance R_s , and 1 for histological specimens evaluation.

Sensitivity and specificity of used methods in relation to identifying occlusal caries-free surfaces were determined. For visual method sensitivity was 71.0% and the specificity 88.2%; for the Diagnodent laser device fluorescence measurements - sensitivity of 93.5%, specificity of 88.2% for 8 being a borderline value for sound tissue (I Hibst's class), whereas sensitivity of 64.5% and specificity 100% assuming 15 as a borderline value for sound tissue (I and II Hibst's class); for conventional X-ray study –sensitivity was equal to 29.0% and specificity to 100%; for radiological study by the Digora system – sensitivity of 48.4% and specificity 100%; for studied ac impedance spectroscopy parameters: T – sensitivity 96.8%, specificity 76.5%; R_b – sensitivity 100%, specificity 76.5%; φ – sensitivity 100%, specificity 100%.

The sensitivity of the studied diagnostic methods as far as the changes within enamel and dentine are concerned were as follows: visual evaluation – 50.0% and 93.3%; the Diagnodent laser device fluorescence measurement – 87.5% and 100% at the borderline value for sound tissue 8 and 37.5% and 90.9% at the borderline for sound tissue 15; conventional X-ray study -0% and 60%; radiological study by the Digora system – 12.5%

and 86.7%; ac impedance spectroscopy parameters: T- 93.0% and 100%; Rb – 100% and 100%; φ – 100% and 100%.

It was found that the advancement of the carious process is accompanied by: the substantial increase of numerical values assigned to the criteria of visual, conventional X-ray and the Digora system radiological evaluations; substantial increase of the Diagnodent fluorescence measurement values and parameter T value; a small decrease of low frequency resistance Rb and significant decrease of phase angle φ value.

It was also observed that the higher the numerical values assigned to visual evaluation criteria the higher are: the fluorescence measured by the Diagnodent laser device, the numerical values assigned to the Digora system radiological study and capacitance parameter T values, and the lower the values of phase angle φ are.

The obtained data shows that:

- the visual examination enables detecting half of early carious lesions on molars occlusal surfaces,
- the conditions of the Diagnodent laser device fluorescence measurements do not influence significantly the obtained measurement values
- the Diagnodent laser device measurement make possible to differentiate sound tissues from carious ones as well as changes within enamel from changes within dentine
- when diagnosing carious lesions on occlusal surfaces it is suggested to assume measurement value equal 8 as a borderline for sound tissue
- X-ray study is not useful for diagnosing early carious changes on occlusal surfaces
- from amongst 4 parameters of equivalent circuit impedance spectroscopy, the value of phase angle φ is most useful for differentiation of carious changes development
- the value of phase angle φ is a reproducible method of ideal sensitivity and specificity with which early carious lesions can be differentiated.