98. EVALUATION OF ACCURACY OF APEX LOCATORS IN ENDODONTICS. A COMPARATIVE META-ANALYSIS OF APL, CBCT AND RADIOGRAPHIC TECHNIQUES.

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Introduction. Determination of the working length accurately is one of the most important steps in endodontic treatment since it will affect the success of instrumentation and obturation of the canal. An inaccurate measurement can result in either under-instrumentation or over-instrumentation which negatively impacts the prognosis of the tooth. There are currently three major ways in which a clinician can measure the working length: using conventional radiography, as well as CBCT, in addition to clinical variables that may be present during the measurement process.

Aim of study. Reviewing the accuracy of the apex locator (APL) compared to conventional radiographic techniques and CBCT for the purpose of determining working length, to identify the techniques that provide the most reliable clinical results.

Methods and materials. Studies comparing APL to both conventional radiography and/or CBCT based upon actual root canal length were reviewed. All quantitative data concerning the measurement of working length accuracy based upon a ±0.5mm margin of error, intraclass correlation coefficient (ICC), Bland Altman analysis, as well as p-values for statistical significance (threshold $p<0.05$) were collected. The different models of APL (Mini Root ZX, Raypex 5, Propex Pixi, RomiApex A-15) as well as the influence of the intracanal environment (NaOCl 2-5.25%, blood, pulp), metallic brackets and various CBCT parameters (FOV, section thickness, voxel size) were also evaluated.

Results. APLs were found to have high accuracy with 100% of all measured lengths being accurate within ±0.5mm in select studies and an overall accuracy of 69.31% under varying clinical conditions. The Rayapex-5 had an accuracy of 84.2%. Radiographs showed much lower accuracy (50.6%) than the APL. The accuracy of CBCT was highly dependent upon the parameters utilized with an ICC of 0.948 and maximum accuracy of 55.3% for 5x5 FOV. An 11.2mm section thickness provided the highest correspondence to the true length. Various environmental factors, including NaOCl concentrations and the presence of metallic brackets affected many of the measurements ($p<0.05$).

Conclusions. Based on the analyzed data, apex locators represent the most reliable and consistent method for determining working length, with minimal errors and no radiation exposure. CBCT provides valuable three-dimensional information, useful in complex cases; however, its use must be justified, considering radiation exposure and cost. Conventional radiography remains a complementary tool but should not be used as the sole method for working length determination. The integration of APL with modern imaging methods can optimize clinical outcomes in endodontics.

Keywords. working length, apex locator, CBCT, periapical radiography, endodontics.

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