Jurnal Kedokteran dan Kesehatan: Publikasi Ilmiah Fakultas Kedokteran Universitas Sriwijaya Volume 12, No 2. 2025/DOI: 10.32539/JKK.V12i2.632 p-ISSN 2406-7431; e-ISSN 2614-0411 Page:267-272

DIGITAL CALIPER VS. INTRAORAL SCANNER: ACCURACY OF UPPER INTER-CANINE WIDTH MEASUREMENTS IN STUDY MODELS

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ARTICLE INFO

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Kata kunci:

Odontologi Forensik Lebar Inter-Kaninus Jangka Sorong Digital Pemindai Intraoral Model Studi

Keywords:

Forensic Odontology Inter-Canine Width Digital Caliper Intraoral Scanner Study Model

Original submisson: January 27, 2025 Accepted: April 28, 2025 Published: April 30, 2025



ABSTRAK

Gigi kaninus rahang atas memiliki dimorfisme seksual yang signifikan, sehingga sering digunakan dalam identifikasi jenis kelamin pada odontologi forensik. Pengukuran lebar inter-kaninus dapat dilakukan dengan cara konvensional menggunakan jangka sorong digital atau secara modern menggunakan pemindai intraoral. Pemindai intraoral menawarkan akurasi lebih tinggi dan kemudahan penyimpanan data, namun belum ada penelitian yang membandingkan lebar inter-kaninus rahang atas mengunakan kedua metode ini. Penelitian ini mengukur lebar inter-kaninus rahang atas pada 80 model studi rahang atas menggunakan kedua alat tersebut, dengan setiap pengukuran dilakukan tiga kali pada satu alat. Hasil pengukuran dianalisis menggunakan SPSS dengan uji kesepakatan ICC, uji normalitas Kolmogorov-Smirnov, dan uji T independen. Hasil uji ICC menunjukkan kesepakatan baik (0,892), dan uji T independen menunjukkan tidak ada perbedaan signifikan antara pengukuran lebar inter-kaninus rahang atas pengukuran bahwa tidak terdapat perbedaan semindai intraoral dan jangka sorong digital.

ABSTRACT

Digital Caliper vs. Intraoral Scanner: Accuracy of Upper Inter-Canine Width Measurements in Study Models. The upper canine teeth exhibit significant sexual dimorphism, making them frequently used in gender identification in forensic odontology. The measurement of the inter-canine width can be performed using conventional methods, such as a digital caliper, or modern methods using an intraoral scanner. The intraoral scanner offers higher accuracy and easier data storage; however, no studies have compared the inter-canine width of the upper jaw using both methods. This study measured the inter-canine width of the upper jaw on 80 jaw models using both instruments, with each measurement performed three times per instrument. The measurement results were analyzed using SPSS, with Intraclass Correlation Coefficient (ICC) for agreement, Kolmogorov-Smirnov for normality, and Independent T-test for significance. The ICC results showed good agreement (0.892), and the Independent T-test revealed no significant difference (p = 0.598). It can be concluded that there is no significant difference between the measurement of the upper inter-canine width using the intraoral scanner and the digital caliper.

INTRODUCTION

Forensic odontology is a subdiscipline of forensic science that utilizes dentists' knowledge and skills for individual identification in the context of investigation or legal proceedings.^{1,2} One of the primary applications of forensic odontology is human identification through dental evidence, which can provide information such as age, sex, and ancestry.³⁻⁵ Determining sex using the upper canine teeth is one of the most commonly used methods because these teeth exhibit a high degree of sexual dimorphism and are highly resistant to trauma, such as natural disasters and fires.⁶⁻⁹ The canine teeth are also the last to be extracted, making them relevant for forensic odontology in relation to age.^{9,10} One of the methods for sex determination using canine teeth involves measuring the inter-canine width of the upper jaw.¹¹

The inter-canine width is generally measured using a digital caliper, which is the conventional method and considered the gold standard due to its practicality, portability, and cost-effectiveness.¹² Digital caliper has been used in various studies that measures tooth dimensions (mesiodistal and buccolingual), inter-canine width, inter-molar width, and fossa depth on teeth.¹³⁻¹⁶ However, this method has limitations in terms of accuracy due to inconsistent placement on dental landmarks. With technological advancements, intraoral scanners have been introduced in dentistry and offer an alternative measurement tool with enhanced accuracy, data storage, and information sharing capabilities. Intraoral scanners have become increasingly used in dentistry for obtaining digital impressions of teeth, providing accurate and distortion-free results.¹⁷⁻¹⁹

However, to date, no studies have compared the measurement of the inter-canine width of the upper jaw using both intraoral scanners and digital calipers. Therefore, this study aims to compare the upper jaw's inter-canine width measurements using digital calipers and intraoral scanners.

METHOD

This study used an analytical, unpaired design with a cross-sectional approach at Rumah Sakit Gigi dan Mulut Pendidikan Universitas Trisakti, from September to November 2024. The sample used for this study was selected through consecutive sampling, with 80 upper jaw study models, aged over 20 years (young adults) and possessing a complete set of upper anterior teeth as inclusion criteria. Individuals with conditions such as crowding and spacing of the upper anterior teeth, undergoing orthodontic treatment, or having canine teeth with attrition, caries, or previous restorations were excluded from the study. The gender distribution of the study models included 49 models from female individuals and 31 from male individuals. The inter-canine width measurement on the upper jaw study models was performed by measuring the linear distance from the cusp tip of the canine tooth in region 1 to the cusp tip of the canine tooth in region 2, using both a digital caliper (Figure 1) and an intraoral scanner (Figure 2).



Figure 1. Upper inter-canine width measurements using digital caliper



Figure 2. Upper inter-canine width measurements using intraoral scanner

The measurements were performed three times using each tool for one sample, resulting in a total of six measurements for each sample. The three measurement results using the same tool were recorded in Microsoft Excel, and the average value was calculated to obtain a single measurement result for each sample. The data were then analyzed using SPSS v26.

RESULT

Three tests were conducted using SPSS: the agreement test using the Intra-Class Correlation (ICC), the normality test using the Kolmogorov-Smirnov test, and the significance test using the independent t-test. The first test performed was the ICC test, which yielded a reliability result of 0.892, indicating a high or good level of reliability.

The second test was the Kolmogorov-Smirnov normality test, which showed that the measurement data using the digital caliper and intraoral scanner were normally distributed, with a value of 0.200 (p > 0.05).

The third test was the independent t-test, which resulted in a value of 0.598 (p > 0.05), indicating that there was no significant difference in the inter-canine width measurements of the upper jaw using the digital caliper and the intraoral scanner.

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DISCUSSION

The results of this study demonstrate that the intraoral scanner can be used as a modern alternative measurement tool in forensic odontology. These findings are consistent with a similar study conducted by Abraham Johnson et al. in 2021, which compared several measurement parameters using a digital caliper and an intraoral scanner. The parameters used in that study included tooth length, crown length, root length, mesiodistal width of the tooth, buccolingual dimension of the tooth, mesiodistal crown width at the cervical part, and buccolingual crown dimension at the cervical part. The study found no significant differences in measurements between the intraoral scanner and the digital caliper for all parameters, except for the mesiodistal crown dimension at the cervical part and the buccolingual dimension of the tooth. The study concluded that both the digital caliper and the intraoral scanner could be used, as the measurements from both tools reached statistical agreement.¹⁷

Another related study involved measurements on 50 pairs of upper and lower jaw study models using a digital caliper and an intraoral scanner. The measurement parameters in this study included 110 key landmarks, such as the buccolingual dimension of anterior and posterior teeth, the crown length of anterior and posterior teeth, and others. Based on the results, the study concluded that there was no significant difference in measurements between the intraoral scanner and the digital caliper. However, the measurements obtained with the intraoral scanner were slightly larger than those taken with the digital caliper. The researchers explained that measurement errors below 0.5 mm were considered insignificant for therapeutic and restorative purposes. However, no standard guidelines exist for acceptable measurement error in forensic odontology. Therefore, their study used a measurement error threshold of 0.5 mm as a reference point.²⁰

Based on this research and the studies mentioned above, several possible factors could explain the differences in measurements obtained using the two tools. First, opinions differ regarding determining landmark points for each measurement.¹⁷ In addition, there is a possibility of calibration errors with both tools.²⁰ In this study, the intraoral scanner was more efficient than the digital caliper in measuring the inter-canine width of the upper jaw. This is because the intraoral scanner only requires one scan of the study model, and multiple measurements can be taken from that single scan. Other than the inter-canine width data, various other information, such as tooth color, crown length, buccolingual tooth dimensions, mesiodistal tooth width, and more, can be obtained from a single scan. Furthermore, the intraoral scanner only needs routine calibration, a maximum of once every seven days, which saves time and effort. On the other hand, repeated measurements using a digital caliper are inefficient and take longer because the movable part of the tool must be reset each time to ensure the measurement results are valid and accurate. In addition, the caliper must be ensured to be clean, and zero calibration needs to be performed each time by pressing the zero button on the tool to avoid affecting the measurement results.

This aligns with a study outlining both tools' advantages and disadvantages. The study concluded that the intraoral scanner, with accuracy comparable to that of the digital caliper, has the advantage of accessibility. According to the survey, the digital caliper is used as a measurement tool because it offers good accuracy, an affordable price, and is practical and portable. However, using the digital caliper requires substantial physical storage space for measured objects, such as the study models. The intraoral scanner offers the benefit of digital data storage, making searching for and distributing data easier. Additionally, only one scan of the study model is needed, and the data

generated can be saved for repeated measurements, whether for distance, volume, or surface area. $^{\rm 12}$

CONCLUSION

Based on research findings and data analysis, it can be concluded that there is no significant difference between the inter-canine width measurements of the upper jaw using a digital caliper and an intraoral scanner. Therefore, the intraoral scanner can be used as an alternative measurement tool in locations with adequate facilities. Conversely, the digital caliper remains an effective measurement tool in areas with limited resources and equipment.

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