Accuracy of Intraoral scanners in post spaces. A systematic review

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Accuracy of Intraoral scanners in post spaces. A systematic review

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Abstract:

Aim. Identification of the precision and accuracy of different intraoral scanners in measuring the depth of the post space during digital impression-taking.

Objective. To identify the depth at which current intra oral scanners can scan into post space preparations and with what level of accuracy compared to other impression methods.

Data sources and search methods. The search was done using MeSH terms and keyword search in the electronic databases namely PubMed, Cochrane, Web of Science and Google Scholar. The studies included in this systematic review were identified by a comprehensive search from the electronic search engines like PubMed Advanced search (Up to April 2023), Cochrane, Web of Science and Google scholar. The search yielded a total of 6 articles out of which 2 articles were only included based on the inclusion criteria.

Conclusion. Intraoral scanners have revolutionized the way post and core restorations are scanned and designed. The use of digital impressions has significantly improved the accuracy and efficiency of the restorative process. However, the current data suggests that improvements in accuracy are still needed, and more homogenous studies are required for a more accurate understanding of post space scanning. With continued advancements in IOS technology, we can expect further improvements in the accuracy and ease of use of this technology in the field of dentistry.

Keywords: Digital Impression, Intraoral Scanner, post and core, depth, accuracy

Introduction:

Intraoral scanners have revolutionized the way dentists approach restorative dentistry, enabling them to achieve greater precision, accuracy, and efficiency in their work. By capturing digital impressions of teeth and soft tissues, IOS has made the process of creating dental restorations faster, more comfortable, and more convenient for patients.

One of the significant advantages of IOS is its ability to scan post and core restorations. These restorations are used to reinforce weakened teeth that have undergone root canal therapy, and traditionally, the process of fabricating them involved using an impression material. This process was often uncomfortable for patients and time-consuming for dentists.

However, with the use of IOS, the process has become simpler, more accurate, and efficient. The scanner can capture the shape and size of the prepared tooth, as well as the post and core restoration, with a high degree of precision. This allows for more accurate planning of the final restoration and reduces the likelihood of remakes or adjustments. By enabling precise measurements and accurate virtual models, IOS significantly improves the accuracy of the restoration, ensuring that it is an optimal fit.

In addition, the digital data captured by the IOS can be used to create a virtual model of the tooth and restoration, which can be easily manipulated in a CAD/CAM system. This enables the dentist to design and fabricate the final restoration with greater precision and efficiency. The virtual model enables the dentist to design restorations that fit perfectly, minimize the chances of a poorly fitting restoration, and eliminate the need for multiple appointments.

The monoblock effect is crucial in post and core restorations, referring to the cohesive bonding between the post, core, and surrounding tooth structure. The post and core materials should have a similar mechanical strength and elastic modulus to the surrounding tooth structure to minimize the risk of stress concentration and fracture. Additionally, the preparation of the tooth and post space should be carefully planned and executed to ensure proper fit and retention. The goal is to create a single, solid unit that distributes occlusal forces evenly, reducing the risk of failure.

The accuracy of IOS plays a significant role in achieving the monoblock effect by providing more accurate digital impressions of the prepared tooth and the post and core restoration. This technology allows for precise planning and fabrication of the restoration, ensuring optimal fit and retention. With continued advancements in IOS technology, we can expect further improvements in the accuracy and ease of use of this technology in the field of dentistry.

Another significant advantage of IOS is the elimination of the need for traditional impression materials. Traditionally, dental impressions were made using putty-like materials that were inserted into a tray and placed in the patient's mouth. Patients often found this process uncomfortable and sometimes experienced gagging or discomfort. Additionally, traditional impressions were often distorted, resulting in the need for remakes or adjustments.

With the use of IOS, dental impressions are more comfortable and convenient for patients, and the risk of distortion is significantly reduced. IOS eliminates the need for impression materials by capturing digital impressions using a camera that is inserted into the patient's mouth. This process is faster, more comfortable, and more accurate than traditional impressions, improving the overall experience for patients.

In conclusion, the use of IOS in dentistry has revolutionized the way dentists approach restorative dentistry. With its ability to capture digital impressions of teeth and soft tissues, as well as scan post and core restorations, IOS has significantly improved the accuracy, precision, and efficiency of dental restorations. Furthermore, its elimination of traditional impression materials makes the process more comfortable and convenient for patients, reducing the need for remakes or adjustments. With continued advancements in IOS technology, we can expect further improvements in the accuracy and ease of use of this technology in the field of dentistry.

Aim
Identification of the precision and accuracy of different intraoral scanners in measuring the depth of the post space during digital impression-taking.

Research Question
What is the depth at which current intra oral scanners can scan into post space preparations and with what level of accuracy compared to other impression methods?

Null Hypothesis
There is no significant variation in the accuracy of digital impressions obtained from different intraoral scanners when measuring the depth of post space preparations compared to other impression methods.

Alternate Hypothesis
There is a significant variation in the accuracy of digital impressions obtained from different intraoral scanners when measuring the depth of post space preparations compared to other impression methods.

Exclusion criteria
- Implant component scanning
- Involved fit evaluation of crown
- Inlay
- Onlay
- Overlay
- Lab scanner

Inclusion criteria
- Post and core
- In Vitro Studies
- Intra oral scanner
- Depth of Scan
- Accuracy
- English

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Materials and Method

The studies included in this systematic review were identified by a comprehensive search from the following search engines using the keywords.

PubMed Advanced search using MeSH terms (Up to April 2023)
Google scholar
Cochrane
Web of Science

Articles in English were only included in the systematic review. The references in the In-Vitro studies were also screened for possible studies.

PICOS

- Population – Teeth prepared with post space
- Intervention – Digital impression using intra oral scanning
- Comparison - Conventional Silicone Impressions
- Outcome – Accuracy of the digital impressions
- Study Design – In Vitro

Search Strategies

Table Web of Science search strategy

Web of Science

#	Search Query	Database	Results
1	(((ALL=(Depth of scan)) OR ALL=(Accuracy)) OR ALL=(Fidelity)) OR ALL=(Reproducibility)	Web of Science Core Collection	1818610
2	ALL=(In vitro)	Web of Science Core Collection	1439554
3	(((((((((((ALL=(In vitro)) OR ALL=(Intraoral scanning technologies)) OR ALL=(IOS)) OR ALL=(Intraoral scanner)) OR ALL=(Confocal microscopy)) OR ALL=(Confocal laser scanning microscope)) OR ALL=(Stereophotogrammetry)) OR ALL=(Optical coherence tomography)) OR ALL=(Software)) OR ALL=(Image processing)) OR ALL=(Video imaging)) OR	Web of Science Core Collection	3596023

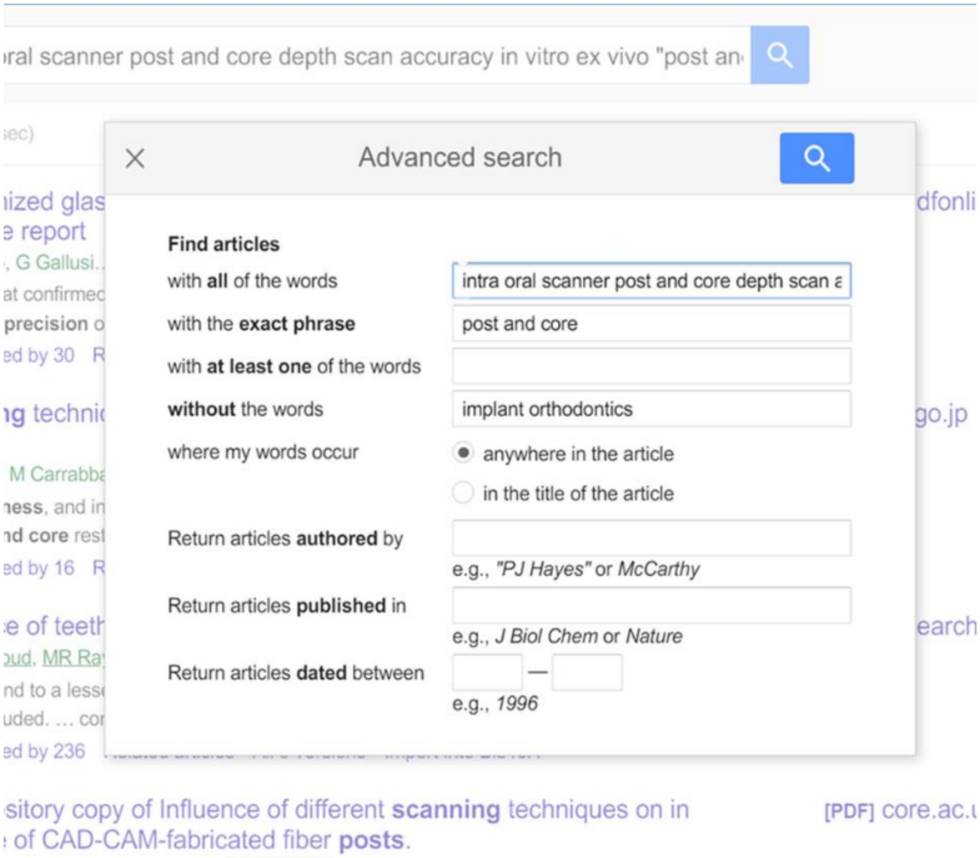
	ALL=(Continuous imaging)) OR ALL=(Triangulation of light)		
4	(ALL=(Post)) AND ALL=(Core)	Web of Science Core Collection	51811
5	(ALL=(Post and core technique)) OR ALL=(Richmond crown)	Web of Science Core Collection	5944
6	(ALL=(Post)) AND ALL=(Core) OR (ALL=(Post and core technique)) OR ALL=(Richmond crown)	Web of Science Core Collection	52239
7	(((ALL=(Depth of scan)) OR ALL=(Accuracy)) OR ALL=(Fidelity)) OR ALL=(Reproducibility) AND ALL=(In vitro) AND (((((((((((ALL=(In vitro)) OR ALL=(Intraoral scanning technologies)) OR ALL=(IOS)) OR ALL=(Intraoral scanner)) OR ALL=(Confocal microscopy)) OR ALL=(Confocal laser scanning microscope)) OR ALL=(Stereophotogrammetry)) OR ALL=(Optical coherence tomography)) OR ALL=(Software)) OR ALL=(Image processing)) OR ALL=(Video imaging)) OR ALL=(Continuous imaging)) OR ALL=(Triangulation of light) AND (ALL=(Post)) AND ALL=(Core) OR (ALL=(Post and core technique)) OR ALL=(Richmond crown)	Web of Science Core Collection	48

Cochrane
(((ALL=(Depth of scan)) OR ALL=(Accuracy)) OR ALL=(Fidelity)) OR ALL=(Reproducibility) AND ALL=(In vitro) AND (((((((((((ALL=(In vitro)) OR ALL=(Intraoral scanningtechnologies))OR ALL=(IOS)) OR ALL=(Intraoral scanner)) OR ALL=(Confocal microscopy)) OR ALL=(Confocal laser scanning microscope)) OR ALL=(Stereophotogrammetry)) OR ALL=(Optical coherence tomography)) OR ALL=(Software)) OR ALL=(Image processing)) OR ALL=(Video imaging)) OR ALL=(Continuous imaging)) OR ALL=(Triangulation of light) AND (ALL=(Post)) AND ALL=(Core) OR (ALL=(Post and core technique)) OR ALL=(Richmond crown)

PubMed
(in vitro) AND (((((depth of scan) OR (depth)) OR (accuracy)) OR (fidelity)) OR (reproducability)) AND (((((("post and core technique"[MeSH Terms] OR ("post"[All

Fields] AND "core"[All Fields] AND "technique"[All Fields]) OR "post and core technique"[All Fields]))) OR (post)) OR (core)) OR (richmond crown))) AND (((((((((((((((((((((((((Intraoral scanning technologies)) OR (intraoral scanning technology)) OR (intraoral scanning technique)) OR (intraoral scanning techniques)) OR (IOSs)) OR (IOS)) OR (confocal microscopy)) OR (confocal microscopies)) OR (confocal laser scanning microscopies)) OR (stereophotogrammetry)) OR (stereophotogrammetries)) OR (optical coherence tomography)) OR (software)) OR (image processing)) OR (video imaging)) OR (continuous imaging)) OR (ultrafast optical sectioning)) OR (ultrafast optical scanning)) OR (parallel confocal microscopy)) OR (triangulation of light)) OR (optical triangulation)) OR (accordion fringe interferometry)) OR (interferometry)) OR (active stereoscopic vision)))

Google Scholar



Google Scholar search strategy fig 1

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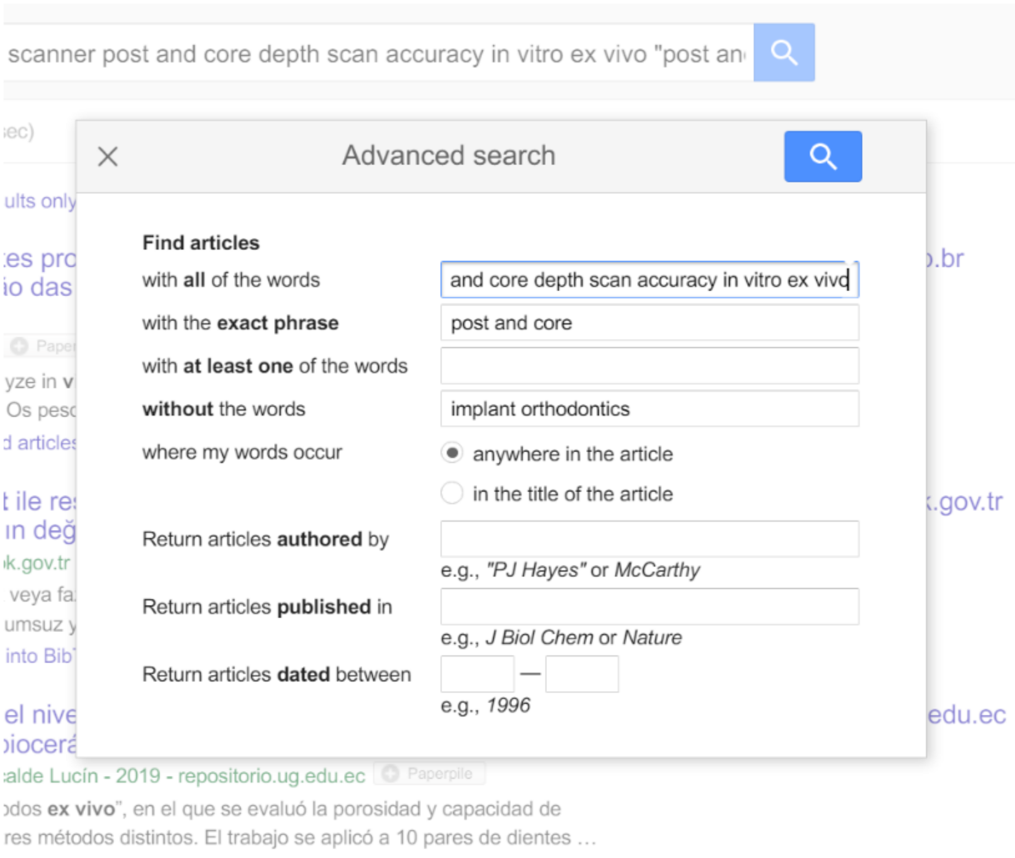

Google Scholar search strategy fig 2

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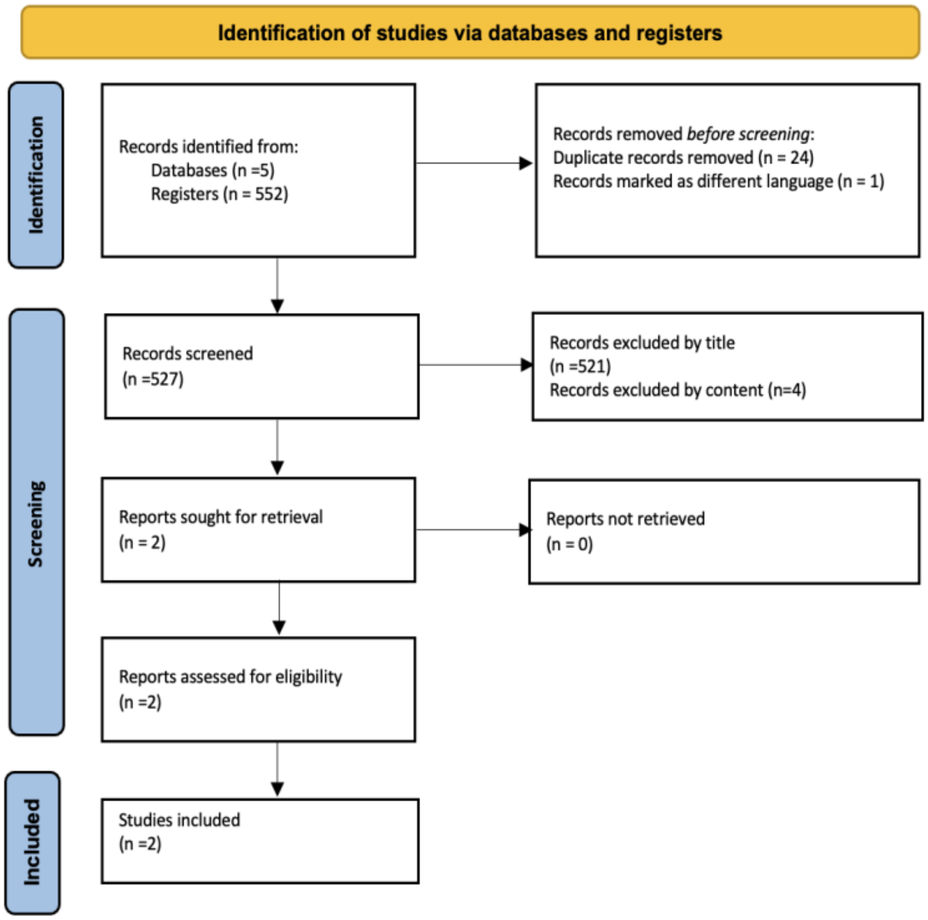
Fig. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources



Variance Table

S no.	Variables of interest
1	Depth of scan
2	Width of post

Table of Excluded Studies

PMID	Title	Authors	Citation	First Author	Journal/Book	Publication Year	DOI	Reason for exclusion
29925710	Effects of scanning technique on in vitro performance of CAD/CAM-fabricated fiber posts	Tsintsadze N, Juloski J, Carrabba M, Goracci C, Vichi A, Grandini S, Ferrari M.	J Oral Sci. 2018;60(2):262-268. doi: 10.2334/josnusd.17-0254.	Tsintsadze N	J Oral Sci	2018	10.2334/josnusd.17-0254	Outcome Parameter not similar
36872156	Scanning accuracy and scanning area discrepancies of intraoral digital scans acquired at varying scanning distances and	Button H, Kois JC, Barmak AB, Zeitler JM, Rutkunas V, Revilla-León M.	J Prosthet Dent. 2023 Mar 3:S0022-3913(23)00067-7. doi: 10.1016/j.prosdent.2023.01.025. Online	Button H	J Prosthet Dent	2023	10.1016/j.prosdent.2023.01.025	Population not similar

	angulations among 4 different intraoral scanners		ahead of print.					
363 347 84	The trueness of an intraoral scanner in scanning different post space depths	Bahar Elter, Burcu Diker, Önjen Tak	Elter, B., Diker, B., & Tak, Ö. (2022). The trueness of an intraoral scanner in scanning different post space depths. Journal of dentistry, 127, 104352. https://doi.org/10.1016/j.jdent.2022.104352	Bahar Elter	J Prosthet Dent	2022	10.1016/j.jdent.2022.104352	Result parameter not similar

35744261	Accuracy of Digital Impression Taking with Intraoral Scanners and Fabrication of CAD/CAM Posts and Cores in a Fully Digital Workflow	Robert Leven, Alexander Schmidt, Roland Binder, Marian Kampschulte, Jonas Vogler, Bernd Wöstmann, Maximiliane Amelie Schlenz	Leven, R., Schmidt, A., Binder, R., Kampschulte, M., Vogler, J., Wöstmann, B., & Schlenz, M. A. (2022). Accuracy of Digital Impression Taking with Intraoral Scanners and Fabrication of CAD/CAM Posts and Cores in a Fully Digital Workflow. Materials (Basel, Switzerland), 15(12), 4199. https://d	Robert Leven	Marterials(Basel)	2022	10.3390/ma15124199	Control group not similar

			oi.org/10.3390/ma15124199					

Table of Included Studies

Study reference	Year of the study	Location of the study	Study design	Population	Number of groups	Intervention	Comparison		
				Sample size		Types of IOS	Control group	Depth of scan	Post space

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A Pinto et al 10.11138/orl/2017.10.4.360	2017	University of Rome "Tor Vergata", Italy	In Vitro	6	2 groups	Digital impression using 3shape TRIOS	Two-component single-phase impression	19.58 % (+/- 13.89) shorter depth reading in digital impression	post space width show non-significant differences
Amir Reza Hendi et al 10.1016/j.prosdent.2018.09.014	2018	Tehran University of Medical Sciences and Health Services	In Vitro	30	3 groups	Indirect silicone impressions of the intracanal space scanned with a 3Shape laboratory scanner (half digital) and intracanal scan posts captured with the intraoral 3Shape TRIOS scanner (fully digital)	Direct acrylic resin patterns (conventional)	Apical gap Conventional 0.11mm fully digital 0.29mm half digital 0.66mm	Nil

Risk of Bias

Study	Sample Justified	Baseline Comparison	I/E Criteria	Method error
A Pinto et al 10.11138/orl/2017.10.4.360	No	Yes	Yes	No

Amir Reza Hendi et al	Yes	Yes	Yes	No

Result

During the initial electronic search, a total of 552 studies were identified. After removing duplicates and non-English studies, 527 studies remained. The title relevance of each study was then reviewed, leading to the exclusion of 521 studies, leaving only 6 studies for abstract screening. Following a thorough analysis of the full text, 4 studies were excluded, resulting in a total of 2 studies for evaluation. Finally, after applying the inclusion criteria, the 2 studies were found suitable for inclusion in the review.

This systematic review has therefore included a total of 2 studies that met the necessary criteria.

Discussion

Intraoral scanners have revolutionized the field of dentistry by providing accurate digital impressions of teeth and soft tissues. This technology has not only improved the efficiency of the restorative process but also enabled dentists to fabricate restorations with greater precision. One area where intraoral scanners have shown promise is in the scanning of post and core restorations, which are used to reinforce weakened or compromised teeth after root canal treatment.

However, despite the advantages offered by intraoral scanners in post and core scanning, there is still room for improvement in terms of accuracy. The data presented by A Pinto et al. and Amir Reza Hendi et al. highlight the potential limitations of digital impressions in accurately reading the post space and achieving optimal retention of the restoration. These findings suggest that the traditional impression technique may still be more accurate in certain cases.

It is important to note that the studies mentioned above were conducted using the 3shape TRIOS intraoral scanner. While the TRIOS is a popular scanner in the dental industry, there are other scanners available on the market that may offer different levels of accuracy and capabilities. It is also possible that improvements in software and hardware technology could address some of the limitations observed in these studies.

Despite the current limitations, intraoral scanners still offer numerous advantages over traditional impression techniques when it comes to post and core scanning. Digital impressions allow for more accurate planning and fabrication of the restoration, as well as the creation of a virtual model that can be easily manipulated in a CAD/CAM system. This enables the dentist to design and fabricate the final restoration with greater precision and efficiency, ultimately resulting in better outcomes for the patient.

To improve the accuracy of intraoral scanners in post and core scanning, further research and development is needed. This could involve improvements in scanner technology, such as the use of higher resolution cameras or the incorporation of artificial intelligence algorithms to better interpret scan data. It could also involve developing new materials for post and core restorations that are more compatible with digital scanning techniques.

In addition to technological advancements, education and training of dental professionals on the use of intraoral scanners for post and core scanning is also important. Dentists must understand the limitations of the technology and be able to identify when a traditional impression technique may be more appropriate. They must also have the skills and knowledge to properly prepare the tooth and post space for optimal fit and retention of the restoration.

In conclusion, while intraoral scanners have shown promise in post and core scanning, there is still room for improvement in terms of accuracy. However, with continued advancements in scanner technology and materials, as well as education and training of dental profe
ssionals, we can expect to see further improvements in the accuracy and ease of use of this technology in the field of dentistry.

Conclusion

Intraoral scanners have revolutionized the way post and core restorations are scanned and designed. The use of digital impressions has significantly improved the accuracy and efficiency of the restorative process. However, the current data suggests that improvements in accuracy are still needed, and more homogenous studies are required for a more accurate understanding of post space scanning. With continued advancements in IOS technology, we can expect further improvements in the accuracy and ease of use of this technology in the field of dentistry.

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