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Evaluation of differences between different tooth surfaces for various intraoral scanners. A Clinical Trial.

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Abstract:
Introduction:
Intraoral scanners have revolutionized dental care, offering precise digital representations of oral structures. Their technology, combining optical sensors and sophisticated software, enables a broad variety of applications in restorative orthodontics, dentistry, implant dentistry, and prosthodontics. Patients benefit from improved comfort and efficiency. As these devices evolve, advancements promise even greater accuracy and integration with CAD/CAM systems. This article compares the Primescan and 3Shape TRIOS 3 scanners to assess their effectiveness and potential enhancements.

Materials and Methodology:
A clinical trial assessed the accuracy of impression-taking using the 3Shape TRIOS and Primescan scanners. Seventeen samples were evaluated, measuring internal gaps between fabricated frameworks and prepared teeth. Silicone replication techniques were employed, and measurements were compared under a stereomicroscope. Ethical approval was obtained from the Saveetha Institute of Medical and Technical Sciences. Intraoral scanners and CAD/CAM technology were utilized, and statistical analysis was conducted to compare measurements across different surface areas.

Results:
Both scanners showed variations in measurements across surface areas, although not all were statistically significant. Group A (3Shape TRIOS) exhibited lower mean measurements compared to Group B (Primescan) across all surface areas. Statistically significant differences were found in overall measurements between the two groups. However, specific surface areas within each group showed inconsistencies in significance.

Discussion:
Previous research has highlighted variations in accuracy among different intraoral scanners. TRIOS has been identified as more accurate for single-tooth scanning, while other scanners show differences in trueness and finish line distinctness. In vitro studies comparing complete arch scanning have shown varying levels of accuracy across different systems and impression materials. Factors such as software version and material type also impact scanner accuracy.

Conclusion:
The intragroup analysis within the 3Shape TRIOS and Primescan scanner groups reveals nuanced variations in measurements across different surface areas. While both scanners exhibit differences in overall accuracy, the significance of these differences varies across specific surfaces within each group. This underscores the importance of considering surface-specific accuracy when evaluating intraoral scanners. Further research and technological advancements are needed to address these variations and enhance the consistency of measurements.
Keywords: Intraoral scanners, CAD, CAM

Introduction:

Intraoral scanners have brought about a significant revolution in dental care, transforming both clinical and patient-facing aspects of the field. These devices have rapidly evolved, driven by advancements in imaging technology, digital dentistry, and materials science. They now stand as versatile instruments empowering dentists and dental technicians to create comprehensive digital representations of oral structures (Kihara et al., 2020).

The intraoral scanner core technology involves a combination of optical sensors, lasers, and sophisticated software algorithms. These components work together to capture precise, high-resolution images of the teeth, gums, and surrounding tissues. This digital data is then converted into 3D models that can be manipulated, analyzed, and utilized for a variety of dental procedures (Mangano et al., 2017).

The applications of intraoral scanners span the entire spectrum of dental care. In restorative dentistry, they facilitate the design and fabrication of crowns, bridges, and veneers with unparalleled precision. By eliminating the need for traditional molds and impression materials, they minimize patient discomfort and potential inaccuracies. In orthodontics, intraoral scanners are indispensable for treatment planning, enabling orthodontists to create virtual models of a patient's teeth, plan movements, and monitor progress over time (S, R., J, J., & T, L. 2022).

In implant dentistry, these scanners assist in the precise placement of dental implants by providing detailed information about available bone structures and adjacent teeth. They also play an essential role in prosthodontics, aiding in the development of dentures, partials, and other removable appliances. Additionally, intraoral scanners have utility in endodontics, allowing for precise measurement and assessment of root canals, vital for successful root canal therapy (Sawase and Kuroshima, 2020) (Takeuchi et al., 2018).

Patient engagement and satisfaction have significantly improved with the integration of intraoral scanners. Patients no longer need to endure the discomfort of traditional impressions, which often induce gagging and anxiety. Instead, they experience a quicker, more comfortable, and less invasive process, leading to increased trust and compliance with recommended treatments (Burzynski et al., 2018).

Looking ahead, the future of intraoral scanners holds exciting possibilities. Ongoing technological advancements promise even higher levels of accuracy, speed, and versatility. Integration with machine learning algorithms and artificial intelligence may enhance diagnostic capabilities and treatment planning. Furthermore, seamless interoperability with CAD/CAM (computer-aided design and computer-aided manufacturing) systems continues to evolve, enabling more efficient and precise production of dental restorations (Nasim, I., Rajeshkumar, S and Vishnupriya, V. 2021) (Nasim I et al., 2020) (Nasim et al., 2022) (Kamath et al., 2022).

In this article, we will compare two well-recognized intraoral scanners, the Primescan and the 3Shape TRIOS 3. Our objective is to provide valuable insights into the effectiveness of these devices, offering a comprehensive overview of their strengths and identifying opportunities for enhancements (Abijeth B et al., 2020).

Materials and methodology:

Study Design

In this clinical trial assessing the accuracy of impression-taking, 17 samples were employed to evaluate and compare the difference in the accuracy of scanned surfaces occlusa, axial, and marginal. The intraoral scanners 3Shape TRIOS and Prime Scan were used for this purpose. Internal gaps between fabricated frameworks and prepared teeth were measured under a stereomicroscope, and the two groups were compared using the silicone replication technique. The study aimed to evaluate the precision of impression-taking of different scanners, which is crucial for determining their effectiveness in capturing detailed impressions for dental applications.

Ethical Approval
The Saveetha Institute of Medical and Technical Sciences in Chennai, India's Institutional Review Board granted approval for the project

Results:
Types of Teeth scanned

Both control and intervention have identical teeth, as they were both performed on the same teeth. Only molar teeth were used for the study. A total of 8 maxillary 1st molars, 6 mandibular 1st molars, 2 maxillary 2nd molars, and 1 mandibular 2nd molar have been recruited.

The mean thickness of the cement space at the three points in the marginal, axial, and occlusal sections was fixed at 100 micrometers for the marginal and axial surfaces and 200 micrometers for the occlusal surface.

Comparison of surfaces within scans

The intragroup comparison within Group A (3Shape) and Group B (Primescan) concerning the discrepancy in linear measurements against the control across different surface areas revealed notable findings. In Group A, the mean marginal measurement was 36.47 micrometers (SD = 28.29), the mean axial measurement was 16.7 micrometers (SD = 10.4), and the mean occlusal measurement was 39.64 micrometers (SD = 30.78). Conversely, Group B exhibited higher mean measurements across all surface areas, with marginal measurements at 61.82 micrometers (SD = 44.86), axial measurements at 33.82 micrometers (SD = 26.95), and occlusal measurements at 64.41 micrometers (SD = 51.9). The Kruskal-Wallis 'H' test depicted statistically significant differences in overall measurements among Group A (H = 65.0, p = 0.02*) and Group B (H = 78.0, p = 0.077), indicating variation within each group. However, when comparing specific surface areas, only the axial vs occlusal measurements showed a statistically significant difference in

Group A (p = 0.026*), while all other comparisons within both groups were not statistically significant (NS). These findings suggest that while there are differences in overall measurements between the two groups, the discrepancies within each group across different surface areas are not consistently significant. (Table 1)

Table 1: Intagroup comparison in Group A (3 SHAPE) and Group B (Prime scan) in relation to cement thickness against control in between different surface area

	Group A (3 Shape) Mean (SD)	Group B (Primescan) Mean (SD)
Marginal	36.47 (28.29)	61.82 (44.86)
Axial	16.7 (10.4)	33.82 (26.95)
Occlusal	39.64 (30.78)	64.41 (51.9)
Kruskal Wallis 'H' test	H = 65.0	H = 78.0
P value, Significance (overall)	p =0.02*	p =0.077 (NS)
Marginal vs Axial	p=0.063 (NS)	p =0.145 (NS)
Marginal vs Occlusal	p=0.927 (NS)	p =0.983 (NS)
Axial vs Occlusal	p = 0.026*	p =0.101(NS)

p> 0.05 – not significant(NS) *p< 0.05 – significant **p< 0.001 – highly significant

Discussion:

The accuracy and dependability of intraoral scanning (IOS) in dentistry are influenced by a multitude of factors spanning technological, methodological, and clinical realms. Research conducted by Hack and Patzelt identified TRIOS as the most precise scanner for single-tooth scanning, while Omnicam and Planscan exhibited lower accuracy in comparison. Similarly, Bartlett and Ricketts found Cerec Bluecam and Omnicam to have lower accuracy in terms of trueness, with True Definition as well as CS 3500 demonstrating the highest accuracy (Bartlett and Ricketts, 2019).

Precision in IOS systems is particularly crucial in prosthodontics, especially concerning the accuracy of finish lines. Nedelcu et al. conducted a study comparing seven IOSs, revealing TRIOS to exhibit the greatest level of finish line distinctness and accuracy. However, DWIO and Planscan showed lower levels of finish line distinctness along with accuracy, suggesting considerable variability among IOSs in finish line quality (Masri and Driscoll, 2022).

In vitro, studies focusing on complete arch scanning have further illuminated the performance of different IOS systems. Kim et al. found TRIOS to demonstrate superior trueness than E4D and Zfx IntraScan scanners, with IOSs requiring powder coating showing superior trueness. Additionally, Ender and Mehl compared digital scanning (CEREC Bluecam and Lava COS) to conventional impressions (Impregum), reporting similar trueness among the digital as well as conventional methods, with CEREC Bluecam exhibiting greater precision (Park and Shim, 2020) (Ender & Mehl, 2011).

However, Patzelt et al. observed discrepancies in accuracy among four IOSs, with CEREC Bluecam being the least accurate as well as Lava COS demonstrating the highest accuracy. This finding has been consistent with their earlier study in 2014, where they evaluated the accuracy of CAD/CAM-created dental casts on the basis of IOS data. Rehmann et al. noted that a recently calibrated Cerec Bluecam exhibited the greatest trueness, which has been followed by Lava COS & iTero (Patzelt, Emmanouilidi, et al., 2014; Patzelt, Bishti, et al., 2014) (Rehmann, Sichwardt, and Wöstmann, 2017) (Patzelt, Emmanouilidi, et al., 2014).

Further comparisons between Omnicam and Bluecam scanners revealed more accurate digital impressions with Omnicam, particularly for complete arch models. However, for single-tooth scanning, both scanners exhibited similar precision. Research by Ender & Mehl and Treesh et al. provided insights into the accuracy of different IOS systems and impression materials, showing varying levels of accuracy across systems (Jeong et al., 2016) (Lee et al., 2017) (Ender & Mehl, 2015) (Treesh et al., 2018).

Regarding software version and material type, Nedelcu and Persson observed significant impacts on scanner accuracy, with greater deviations noted in areas of changing curvature. Moreover, Su and Sun reported a decrease in precision with an increase in the scanned arch area, underscoring the challenges in directly comparing IOS accuracy across different studies (Nedelcu and Persson, 2014) (Su and Sun, 2015).

Intragroup analysis within each scanner group showed variations in measurements across different surface areas, although not all were statistically significant. While both groups exhibited differences in overall measurements, the discrepancies within specific surface areas were not consistently significant. This indicates that while both scanners demonstrate differences in overall accuracy, their performance varies across different surfaces within the same scanner group.

Conclusion:

In conclusion, the intragroup analysis conducted within the 3Shape TRIOS and Primescan scanner groups highlights nuanced variations in measurements across different surface areas. While both scanners exhibit differences in overall accuracy, the statistical significance of these differences varies across specific surfaces within each scanner group. This underscores the significance of considering not only the overall performance but also the surface-specific accuracy when evaluating intraoral scanners. Further research and refinement in scanner technology may help to address these variations and improve the consistency of measurements across all surface areas.

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