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Comparison of the accuracy of various intraoral scanners. A clinical trial.

[1]Dr. Sashwat Sathish, [2]Dr. Manish Ranjan, [3]Dr. Surendar Sugumaran

Department of Conservative dentistry and Endodontics,
Saveetha Dental college and hospitals
Saveetha Institute of Medical and Technical sciences (SIMATS)
Saveetha University,
Chennai - 600077, Tamil Nadu, India
Email id: 152106007.sdc@saveetha.com

Department of Conservative dentistry and Endodontics,
Saveetha Dental college and hospitals,
Saveetha Institute of Medical and Technical sciences (SIMATS),
Saveetha University,
Chennai - 600077, Tamil Nadu, India
Email id: manish@saveetha.com

Department of Conservative dentistry and Endodontics,
Saveetha Dental college and hospitals,
Saveetha Institute of Medical and Technical sciences (SIMATS),
Saveetha University,
Chennai - 600077, Tamil Nadu, India
Email id: surendar.sdc@saveetha.com

Corresponding author:Dr. Manish Ranjan

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Abstract:

Introduction:

Intraoral scanners have transformed dental care, offering precise digital impressions for various procedures. This study compares the effectiveness of two prominent scanners, Primescan and 3Shape TRIOS 3, in capturing dental impressions for restorative purposes.

Materials and Methodology:

Seventeen patients participated in a clinical trial to evaluate impression-taking accuracy. Internal gaps between fabricated frameworks and prepared teeth were measured using stereomicroscopy and silicone replication technique. The scanners' precision in capturing detailed impressions was assessed.

Results:

Significant differences were observed in marginal, axial, and occlusal measurements between the two groups. 3Shape TRIOS 3 exhibited slightly superior accuracy compared to Primescan. However, both scanners showed no significant difference compared to control cement thickness, indicating comparable clinical effectiveness.

Discussion:

The accuracy of intraoral scanners is critical for successful dental procedures. Comparative studies highlight variations in accuracy among different scanners. Factors such as software version, material type, and scanned arch area influence scanner accuracy. Primescan and 3Shape TRIOS 3 demonstrate varying degrees of accuracy in capturing dental impressions.

Conclusion:

3Shape TRIOS 3 shows slightly superior accuracy in marginal, axial, and occlusal measurements compared to Primescan. However, both scanners exhibit comparable clinical effectiveness. These findings contribute to understanding the evolving landscape of intraoral scanning technology in modern dentistry.

Keywords: Intraoral scanners, accuracy, primescan, 3Shape TRIOS

Introduction:

Intraoral scanners have brought about a significant paradigm shift in dental care, reshaping both the clinical and patient-facing aspects of the field. These devices have evolved rapidly, driven by advancements in imaging technology, digital dentistry, and materials science. Today, they stand as versatile instruments that empower dentists and dental technicians to develop a comprehensive digital depiction of the patient's oral structures. (Kihara et al. 2020)

The core technology behind intraoral scanners involves a combination of optical sensors, lasers, and sophisticated software algorithms. These elements work in harmony to capture precise, high-resolution images of the teeth, gums, and surrounding tissues. This digital data is then transformed into 3D models that can be manipulated, analyzed, and utilized for a wide range 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 have minimized patient discomfort and the potential for inaccuracies. In orthodontics, intraoral scanners have become indispensable tools 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 aid in the precise placement of dental implants by providing detailed information about the available bone structure and adjacent teeth. They also play a pivotal role in prosthodontics, where they assist in the development of dentures, partials, and other removable appliances. Moreover, intraoral scanners have found utility in endodontics, allowing for precise measurement and assessment of root canals, which is vital for successful root canal therapy.(Sawase and Kuroshima 2020)(Takeuchi et al. 2018)

Patient engagement and satisfaction have improved significantly with the integration of intraoral scanners. Patients no longer have to endure the discomfort of traditional impressions, which often induce gagging and anxiety. Instead, they experience a quicker, more comfortable, and less invasive process, which can lead 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, the seamless interoperability of intraoral scanners 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)(Kamath et al., 2022)(Nasim et al., 2022)

In this article, we will be comparing two well-recognized intraoral scanners, the Primescan and the 3Shape TRIOS 3. Our objective is to offer 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 intraoral scanners 3Shape TRIOS and Prime Scan. 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 with these 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.

Armamentarium

Intraoral Scanners:

Prime Scan Intraoral Scanner

3Shape Trios Intraoral Scanner

Impression Material:

Light and Putty Consistency Poly Vinyl Siloxane Impression Material
Microscope:
Stereoscopic Microscope
CAD/CAM Technology:
Dentsply Sirona CEREC MCXL
Tessera CAD/CAM Blocks

Results

The present study recruited a total of 17 patients, with each patient undergoing both control and intervention procedures.

Types of Teeth

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 first molars, 6 mandibular first molars, 2 maxillary second molars, and 1 mandibular second molar were 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 marginal and axial surfaces and 200 micrometers for the occlusal surface. (Janani K et al., 2020)(Aparna J, Maiti S and Jessy P 2021)

Marginal Surface

Marginal measurements between Group A (3Shape) and Group B (Primescan) show that Group A has a mean marginal measurement of 134.71 micrometers with a standard deviation of 30.56 micrometers, while Group B has a higher mean of 161.35 micrometers with a standard deviation of 45.55 micrometers. A t-value of -2.003 and a matching p-value of 0.044 were retrieved from the unpaired t-test. Statistical significance is achieved at the 0.05 level since the p-value<0.05. This suggests that the marginal measurements of Group A and Group B differ statistically significantly. Specifically, Group B (Primescan) tends to have higher marginal measurements compared to Group A (3Shape). (Tables 1, 2 and 3)

Axial surface

Axial measurements between Group A (3Shape) and Group B (Primescan) show that Group A has a mean marginal measurement of 91.88 micrometers with a standard deviation of 18.29 micrometers, while Group B has a higher mean of 119.59 micrometers with a standard deviation of 39.16 micrometers. The unpaired t-test yielded a t-value of -2.642 with a matching p-value of

0.013. At the 0.05 level, the result is statistically significant because the p-value<0.05. This suggests that Group A and Group B's marginal measures differ statistically significantly from one another. Specifically, Group B (Primescan) tends to have higher axial measurements compared to Group A (3Shape). (Tables 1, 2 and 3)

Occlusal Surface

Occlusal measurements between Group A (3Shape) and Group B (Primescan) show that Group A has a mean marginal measurement of 191.88 micrometers with a standard deviation of 50.47 micrometers, while Group B has a higher mean of 240.06 micrometers with a standard deviation of 73.46 micrometers. The unpaired t-test yielded a t-value of -2.229 with a matching p-value of 0.033. At the 0.05 level, the result is statistically significant because the p-value<0.05. The marginal measures of Group A and Group B differ statistically significantly, according to this. Specifically, Group B (Primescan) tends to have higher Occlusal measurements compared to Group A (3Shape). (Tables 1, 2 and 3)

Table 1: Descriptive statistics of cement space in Group A (3 Shape)

Group A (3 Shape)	Mean (µm)	SD (µm)	SE (µm)	Minimum (µm)	Maximum (µm)
Marginal	134.71	30.56	7.41	85.0	212.0
Axial	91.88	18.29	4.43	67.0	135.0
Occlusal	191.88	50.47	12.24	90.0	247.0

Table 2: Descriptive statistics of cement space in Group B (Primescan)

Group B (Primescan)	Mean (µm)	SD (µm)	SE (µm)	Minimum (µm)	Maximum (µm)
Marginal	161.3	45.55	11.04	96.0	277.0
Axial	119.5	39.16	9.5	66.0	175.0
Occlusal	240.06	73.46	17.81	110.0	421.0

Table 3: Intergroup comparison between Group A (3 SHAPE) and Group B (Prime scan) respectively in relation to cement space

	Group A (3 Shape) Mean (SD) (µm)	Group B (Primescan) Mean (SD) (µm)	Unpaired t-test	P value, Significance
Marginal	134.71 (30.56)	161.35 (45.55)	t = -2.003	p =0.044*
Axial	91.88 (18.29)	119.59 (39.16)	t = -2.642	p =0.013*
Occlusal	191.88 (50.47)	240.06 (73.46)	t = -2.229	p =0.033*

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

Discussion

The accuracy and reliability of intraoral scanning (IOS) in dentistry are influenced by a myriad of factors encompassing various technological aspects, scanning strategies, and clinical applications. Studies conducted by Hack and Patzelt revealed TRIOS as the most accurate scanner for single-tooth scanning, while Omnicam and Planscan were found to be less accurate in comparison. Similarly, Güth et al. reported Cerec Bluecam and Omnicam to have lower accuracy in terms of trueness, with True Definition and CS 3500 being the most accurate. (An in-vitro study evaluating the precision of six intraoral scanning systems, no date)(Bartlett and Ricketts, 2019)

The accuracy of IOS systems becomes particularly critical in prosthodontics, especially concerning the precision of finish lines. Nedelcu et al. conducted a study comparing seven IOSs, finding TRIOS to exhibit the maximum degree of distinctness at the finish line and accuracy. However, other systems like DWIO and Planscan displayed lower levels of finish line distinctness

and accuracy, suggesting considerable variations among IOSs in terms of finish line quality. (Masri and Driscoll, 2022)

In vitro studies focusing on complete arch scanning have further elucidated the performance of different IOS systems. Kim et al. found TRIOS to exhibit better trueness in contrast to E4D and Zfx IntraScan scanners, with IOSs requiring powder coating demonstrating superior trueness. Ender and Mehl also reported comparable trueness between digital and conventional procedures when comparing digital scanning (Lava COS and CEREC Bluecam) to conventional impressions (Impregum). CEREC Bluecam demonstrated greater precision in this comparison. (Park, Shim, and Kim, 2018)Mehl and Ender (2011)

However, Patzelt et al. found differences in accuracy among four IOSs, with CEREC Bluecam being the least accurate and Lava COS exhibiting the highest accuracy. This finding was consistent with their earlier study in 2014, where they evaluated the accuracy of CAD/CAM-generated dental casts based on IOS data. Rehmann et al., using a recently calibrated Cerec Bluecam, recorded the highest trueness, followed by iTero and Lava COS.(Patzelt, Emmanouilidi, et al., 2014)(Patzelt, Bishti, et al., 2014)(Rehmann, Sichwardt and Wöstmann, 2017)

Further comparisons between Omnicam and Bluecam scanners showed more accurate digital impressions with Omnicam, especially for complete arch models. However, for single-tooth scanning, both scanners exhibited similar precision. Research by Ender and Mehl and Treesh et al. [36] provided insights into the accuracy of different IOS systems and impression materials, with varying levels of accuracy reported across systems. (Jeong et al., 2016)(Lee et al., 2017)(Ender and 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 decline in precision with an increase in the scanned arch area, emphasizing the challenges in directly comparing IOS accuracy across different studies.(Nedelcu and Persson, 2014)(Su and Sun, 2015)

These findings are in line with the findings found in this study, in which they compared the accuracy and efficiency of two digital intraoral scanners, 3Shape (Group A) and Primescan (Group B), in capturing dental impressions for restorative procedures. The findings revealed statistically

significant differences in marginal, axial, and occlusal measurements between the two groups, with Primescan consistently showing higher mean measurements compared to 3Shape. This suggests that 3Shape TRIOS may offer slightly superior accuracy in capturing dental dimensions in these specific areas. Both scanners did not show a statistical difference compared to the control cement thickness indicating no clinical significance in the variation of accuracy between both scanners. (Kamath, K. A., Nasim, I., & Rajeshkumar, S. 2020)(Siddique et al., 2020)

Conclusion

3Shape TRIOS 3 exhibited slightly superior accuracy in marginal, axial, and occlusal measurements compared to Primescan, with differences observed between the two groups. Both scanners did not show a difference compared to the control cement thickness indicating no clinical significance in the variation of accuracy between both scanners.

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