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Comparison of scan and design times of various intraoral scanners. A clinical trial.

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Abstract:

Introduction:

The digital revolution in dentistry has ushered in transformative changes, propelled by advancements in intraoral scanning technology and CAD/CAM workflows. This study investigates the comparative efficiency of two prominent intraoral scanners, Trios 3 and Primescan, focusing on scanning and design times for crown restorations.

Materials and Methodology:

Seventeen patients participated in this in vivo study, undergoing scanning procedures using both Trios 3 and Primescan intraoral scanners. Crown designs were subsequently executed using respective software platforms. Statistical analysis was conducted to compare scanning and design times between the two scanners.

Results:

Scanning time analysis revealed no significant difference between Trios 3 and Primescan. However, a substantial variation was observed in design times, with Primescan demonstrating significantly reduced time compared to Trios 3. Detailed descriptive statistics and intergroup comparisons are provided.

Discussion:

The findings highlight Primescan's advantage in offering a more efficient workflow during the design phase of restorative procedures, attributed to its auto-designing features. Comparisons with previous studies underscore the broader trend toward time efficiency and enhanced clinical outcomes associated with digital impressions in dentistry.

Conclusion:

Primescan emerges as a promising intraoral scanner, significantly reducing design time for crown restorations compared to Trios 3. Both scanners offer similar scanning times, contributing to the growing evidence supporting the efficacy of digital impressions in streamlining clinical workflows and improving treatment outcomes in dentistry.

Keywords: Intraoral scanner, Scan time, Design time, Prime scan, 3Shape TRIOS

Introduction:

The landscape of dental treatment has been reshaped by digital innovations within the field of dentistry. With advancements in technology, new materials boasting enhanced physical and aesthetic qualities have emerged, challenging the limitations of conventional methodologies. Integral to this evolution is the advent of sophisticated devices like laboratory scanners and CNC (computer numerical control) milling machines, which have catalyzed the introduction of novel materials into the dental market. The genesis of digital innovations in dentistry can be traced back to dental laboratories, where the foundations of dental CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing) workflows were laid. However, a pivotal moment in this

journey occurred with the introduction of IOSs (Intraoral Scanners) into dental offices, empowering dentists to immerse themselves in the digital realm.(Beuer, Schweiger, and Edelhoff 2008; Pradíes et al. 2015; Sulaiman 2020; Persson, Andersson, and Bergman 1995)

The inception of laboratory-connected IOSs in 2007 by the Massachusetts Institute of Technology (MIT) marked a significant milestone in dental technology. Subsequently, a multitude of IOSs have inundated the dental market, prompting extensive scientific inquiry into their comparative properties with traditional impression-taking methods. Studies have predominantly focused on aspects such as the approval of digital IOSs by dental professionals and patients, the accuracy of IOS devices, as well as the time efficiency of digital impression-taking processes. Recent investigations have indicated a preference among dental professionals for digital impressions over traditional materials, albeit with varying conclusions regarding accuracy.(Zimmermann et al. 2015; Richert et al. 2017; Burhardt et al. 2016; Park et al. 2015; Schepke et al. 2015; Christopoulou et al. 2022; Joda and Brägger 2016; Resende et al. 2021; Sfondrini et al. 2018; Yuzbasioglu et al. 2014)

The ongoing refinement of software and the introduction of newer generations of IOS devices have further propelled the evolution of digital impressions in dentistry. Manufacturers frequently release updated versions of their software to enhance device properties, while new generations of IOS devices signify substantial hardware advancements. Among the parameters scrutinized in evaluating IOS performance, scanning time has emerged as a focal point, with studies consistently demonstrating the efficiency of digital impression-taking compared to traditional methods.(Goracci et al. 2016; Sacher et al. 2021; Michelinakis et al. 2021) (Abijeth B et al,. 2020) (S, R., J, J., & T, L. 2022) (Nasim, I., Rajeshkumar, S and Vishnupriya, V. 2021)

Against this backdrop, the present in vivo study aims to elucidate the scanning and design times associated with crowns using the Trios 3 IOS and the Primescan IOS, utilizing their respective software.

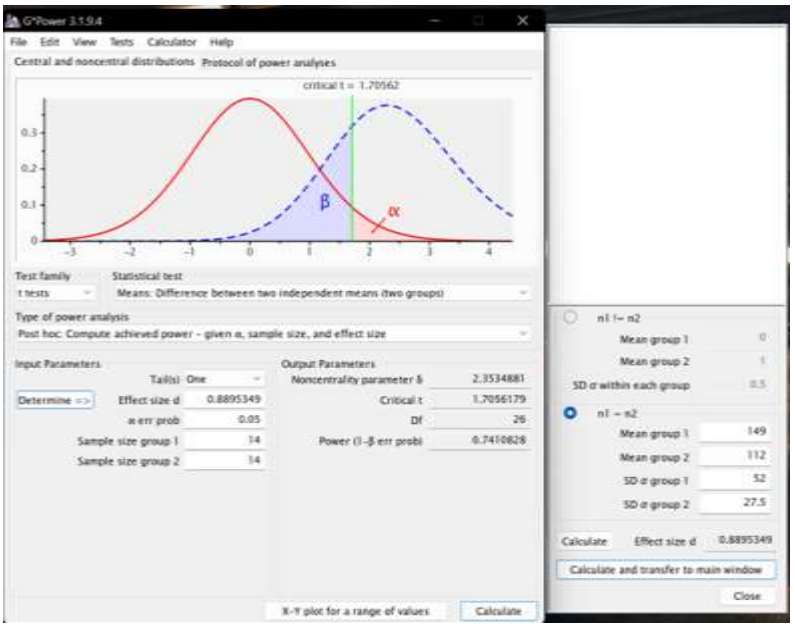
Materials and methods:

Ethical Approval

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

Sample Size Determination

The sample size had been measured employing a investigation carried out by Boeddinghaus M et al., 92015) as a reference.



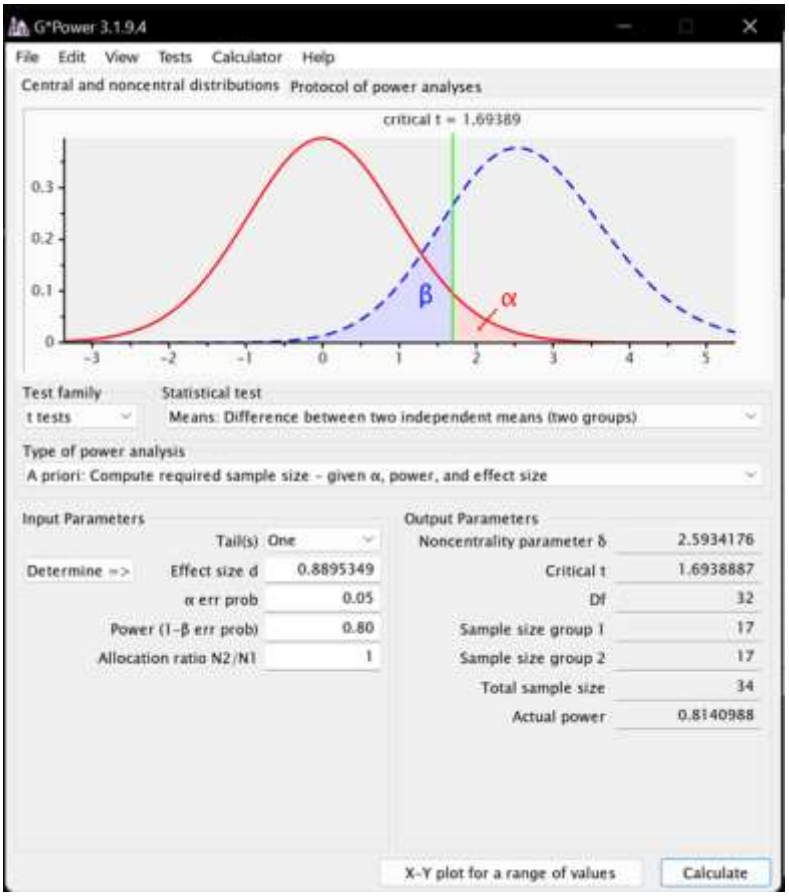


Figure 1: The power analysis was executed through the utilization “of G*Power software version 3.1.9.4.

The power analysis, guided by an effect size (f) of 0.88, an alpha error probability of 0.05, & a targeted power of 0.80 unveiled a necessity" for a minimum of 17 specimens per workflow.

Groups
Group A (n=17) – Scanning done using Prime scan intraoral scanner

Group B (n=17) – Scanning done using 3Shape TRIOS

Scanners:

The study utilized two intraoral scanners: the Prime Scan Intraoral scanner, courtesy of Dentsply Sirona, and the 3Shape TRIOS Intraoral scanner, courtesy of 3Shape.

Scanning Procedure:

Scanning time was assessed for single quadrant scanning on single-tooth crown preparations using both the Prime Scan and 3Shape TRIOS scanners.

Designing Software:

Designing time was evaluated using software platforms Connect SW 5 version 5.2.6.278165 for the Prime Scan and 3Shape TRIOS version 3.1 for the 3Shape TRIOS.

Crown Design:

All digital scans obtained were used to design Modified Lithium Disilicate crowns. The designs were performed by the same operator to maintain consistency across the study.

Workflow and Design Principles:

All crowns were produced using the same workflow and adhered to consistent design principles. Specifically, a cement gap of 100 μm was maintained throughout the design process to ensure uniformity.

Crown Material:

The crowns were fabricated using CEREC Tessera Advanced Lithium Disilicate material, sourced from Dentsply Sirona, Charlotte, USA. This standardized choice of material aimed to minimize variability in crown properties and ensure a fair comparison between scanning and design methods.

Operator Training and Calibration:

Prior to the commencement of the study, the operators underwent training and calibration sessions to familiarize themselves with the scanning devices, software platforms, and crown design procedures. This step aimed to minimize operator bias and ensure the accuracy and reliability of the outcomes.

Statistical Analysis:

Microsoft Office Excel 2010 will be used for data entry, and SPSS version 22 software will be used for "results analysis. For quantitative variables, descriptive statistics like the mean and Standard Deviation (SD) will be" computed. A fixed p-value of 0.05 had been used. The Shapiro-Wilk test had been utilized to verify that the data was normal. An unpaired t-test had been "employed for the intergroup comparison among the values of both groups. Mann Whitney U test was employed for intergroup comparison between both" group's discrepancies in linear measurements. Overall intragroup comparison between different surfaces will be done using "the Kruskal Wallis 'H' test as well as pairwise comparison using the Mann Whitney U test for pairwise" comparison.

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, six mandibular first molars, 2 maxillary 2nd molars, & 1 mandibular 2nd molar had been recruited.

Scanning times

For scanning time, Group A utilizing 3Shape recorded an average time of 66.64 sec with a standard deviation (SD) of 12.37 sec, while Group B employing Primescan had an average time of 69.41 sec with an SD of 9.24 sec. The difference in scanning time among the two groups is not statistically significant ($p>0.05$), according to the unpaired t-test, which produced a t-value of -0.739 and a matching p-value of 0.466. Therefore, the difference is deemed non-significant (NS) at the 0.05 level, suggesting that there is no significant discrepancy in scanning time between Group A and Group B (Tables 1, 2 & 3) (Figure 1)

6.7 Designing times

For design time, Group A utilizing 3Shape recorded an average time of 548.88 sec with an SD of 84.26 sec, while Group B employing Primescan had an average time of 126.82 sec with an SD of 28.61 sec. The unpaired t-test led to a highly significant t-value of 19.554 with a corresponding p-value <0.001**. This denotes a highly significant variation in design time between the two groups, with Group A requiring substantially more time for design compared to Group B (Tables 1, 2 & 3) (Figure 2)

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

Group A (3 Shape)	Mean (Seconds)	SD (Seconds)	SE (Seconds)	Minimum (Seconds)	Maximum (Seconds)
Scanning time	66.64	12.37	3.0	48.0	90.0
Design time	548.8	84.26	20.43	395.0	720.0

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

Group B (Primescan)	Mean (Seconds)	SD (Seconds)	SE (Seconds)	Minimum (Seconds)	Maximum (Seconds)
Scanning time	69.41	9.24	2.24	52.0	88.0
Design time	126.82	28.61	6.94	80.0	174.0

Table 3: Intergroup comparison between Group A (3 SHAPE) and Group B (Primescan) in relation to scanning and design time

	Group A (3 Shape) Mean (SD) (Seconds)	Group B (Primescan) Mean (SD) (Seconds)	Unpaired t-test	P value, Significance
Scanning time	66.64 (12.37)	69.41 (9.24)	t = -0.739	p =0.466 (NS)
Design time	548.88 (84.26)	126.82 (28.61)	t = 19.554	p< 0.001**

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

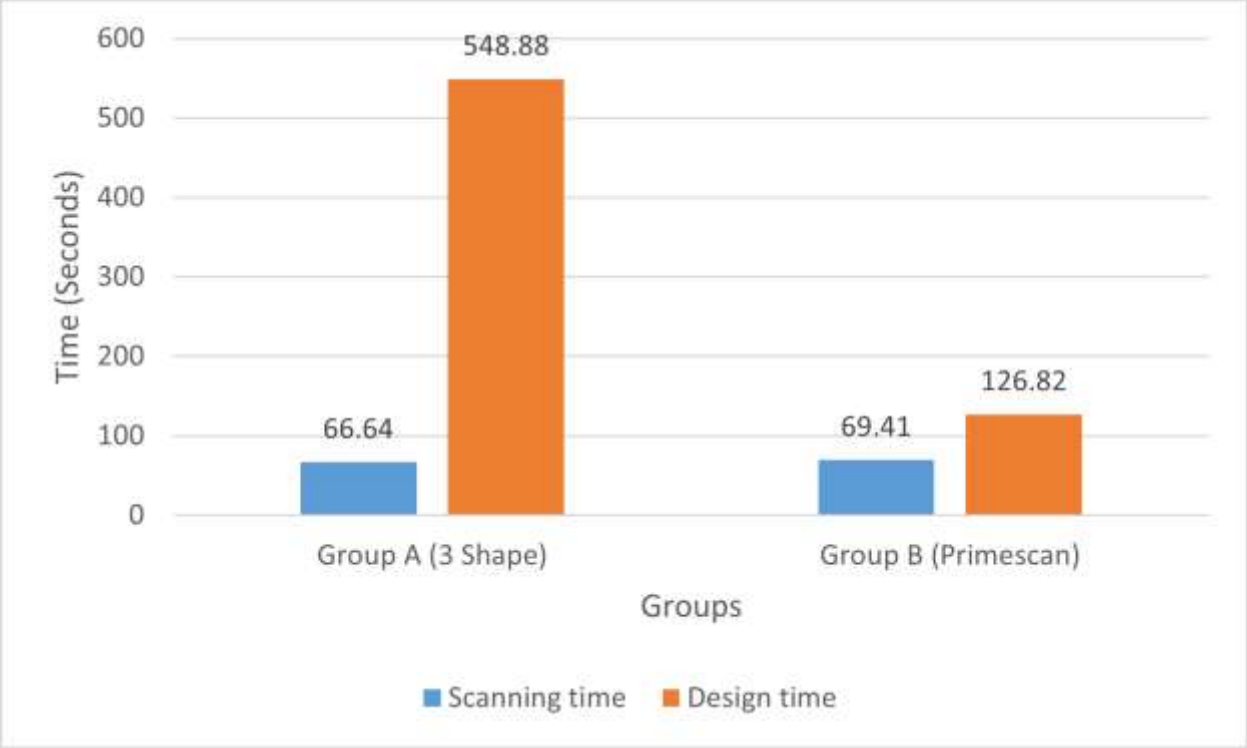


Figure 2: Intergroup comparison between Group A (3 SHAPE) and Group B (Primescan) in relation to times

Discussion:

Regarding efficiency that is scanning time, there was no statistically significant variation in scanning time between the 2 groups. Nevertheless, a significant variation had been observed in the design time, with 3Shape requiring substantially more time compared to Primescan. This highlights Primescan's advantage in offering a more efficient workflow in the design phase of restorative procedures due to the auto-designing features present in its CEREC software.(Siddique et al., 2020) (Janani K et al., 2020) (Aparna J, Maiti S and Jessy P 2021)

Different studies also noted that when comparing intra-oral Oral Scanning (IOS) to conventional impressions, a distinct trend toward lessened working hours was observed for IOS in contrast to conventional perceptions. Additionally, IOS was linked to a higher mean number of retakes but a reduced mean retake time. This finding could be explained by the fact that when employing digital impression techniques, doctors were more inclined to take benefit of the opportunity to rescan a missing zone. Retaking a traditional impression, on the other hand, would require starting over from scratch. Time efficiency outcomes can be affected by a wide range of factors, “including the

type of IOS system used, operator expertise, comfort level, and the start as well as endpoints selected for procedure working time measurement. Using a first-generation IOS system (Bluecam; Dentsply Sirona), Sailer et al., 2019 found a rather high mean procedure working time of 28.4 minutes for digital impressions. This step is not necessary with current models. Some of the initial clinical trials showed a trend toward longer working hours for older IOS systems. Furthermore, it" is necessary to compare digital impressions with the particular kind of traditional imprint process that is being used. Benic et al. (2016) employed a closed-mouth conventional imprint technique that made it possible to take a single-step impression of both jaws and occlusal registration. This could be the cause of the traditional impression method's speed advantage over IOS in this particular test.(Resende et al. 2021; Kim, Benic, and Park 2021)(Siqueira et al. 2021)(Siqueira et al. 2021; Ahlholm et al. 2018)(Boeddinghaus et al. 2015)(Wismeijer et al. 2014)(Wismeijer et al. 2014; Benic et al. 2016)

The capability of iOS to rescan missed areas as well as previsualize areas, enabling real-time feedback, is a significant benefit over traditional impressions. An inaccuracy in a conventional imprint is frequently only noticeable after the impression material has set completely or after pouring a stone cast. Rescanning to "fix" a particular feature of the scan that isn't good can be helpful, but it's crucial to remember that a good scanning strategy can cut down on the amount of time it takes to complete the process by preventing the need for this extra step. (Nasim I et al., 2020) (Kamath et al., 2022) (Nasim et al., 2022) (Kamath, K. A., Nasim, I., & Rajeshkumar, S. 2020)

It has already been shown that an operator's experience level has a significant impact on IOS working time. Resende and associates demonstrated that, in comparison to operators with moderate and high levels of experience, less experienced operators needed noticeably longer timeframes for IOS. Since the time difference was only 70 sec., it is probably not clinically significant. Four of the 14 studies in our analysis that reported working hours did not provide a detailed description of the operator's experience level with IOS. Interestingly, IOS was found to be faster than conventional impressions in all four of these trials. The operators were characterized in all the remaining investigations as being skilled or having received sufficient training and calibration prior to the clinical procedures.(Giménez et al. 2014)(Resende et al. 2021)

Conclusion:

Primescan demonstrated a more efficient design workflow, significantly reducing designing time compared to 3Shape. Both scanners showed similar scanning times. Both 3Shape TRIOS 3 and Primescan did not show variation within the scanned surfaces.

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