Comparison of Experience Curves Between 3 Shape Trios® and Medit® Intraoral Scanner

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Abstract

Objective: To compare the experience curves between two intraoral scanners (Trios® and Medit®) among undergraduate dental students (Fifth and sixth year) and to determine whether iterated scanning could affect scan time.

Method: Twenty-four undergraduate dental students were recruited in this study, the dental students were allocated into two groups, Medit® and Trios®. Each subject was required to scan according to this sequence: one time in dentoform, ten times in patient, one time in dentoform. The scan time and actual time were recorded in two terms namely the actual time and scan time. Actual time refers to time since the begining until the end of scanning session. The scan time represents the time that was shown in the software.

Result: The average of the actual time of twelve sessions was greater with Medit® than Trios®, but a greater decrease in average of actual time was observed in Medit®. Unlike the learning rate of Medit®, Trios® was influenced by patient factor.

Conclusion: The learning rate for Medit® was faster whereas the average actual time of Medit® was greater than Trios®. There was slightly difference between experience curve of Medit® and Trios®.

Keywords: *Undergraduate dental student*

1. Introduction

Intraoral scanner (IOS) is an equipment which digitally records three dimensional (3D) image directly from the oral cavity. IOS is similar to 3D-scanner due to its light source (e.g. white light, red laser and blue LED, etc.). The principle of IOS is using the reflected light from the object which send back to the sensor forming point cloud. Then, point cloud is processed by scanning software in the form of triangular data, which will be used to make the surface of the 3D-object.

IOS became popular among users. The utility of IOS has been widely applied in many fields of dentistry including prosthodontics, restoratives, orthodontics, etc. It helps eliminate the limitation of an old fashion impression taking and dental stone cast. Its accuracy has been proved to be enough for all kinds of laboratory dental work 4.5 ± 0.9 µm (Hack, Patzelt, 2015).

However, IOS is still considered as a very new innovation which unavoidably required a completely new set of skills (Burzynski, Firestone, Beck, Fields & Deguchi, 2018). Although most of the IOS's inventors have claimed their ease of use in terms of its convenient and its short scanning time, some dentists, especially orthodontists who need to do a complete full-mouth scan, may hesitate to step away from conventional impressions to do a digital scanning.

After continuous development, IOS increasingly becomes more user-friendly. Nowadays, there are many intraoral scanners in the market such as Trios®, iTero®, Strauman®, 3M®, etc. One of the well-known commercially intraoral scanners in dentistry is Trios®. It has the greatest precision (35.6 ± 3.4 µm) in full-arch scanning when compared to other IOS (Mangano et al, 2019). Also, Trios3® used a CMOS sensor of 3000 frames per second (Ahn, Park, Kim, Lee & Eom, 2017).

While IOS was introduced by western-country in 2000, Identica company in South Korea had released Medit i500 which was a more update version of IOS. Even studies on this IOS is still insufficient, many clinicians claimed that its function and scan experience can rival some of the top scanners in the market with a smaller price.

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Table 1 Comparison between Medit® and Trios®

	Producer	Technology of acquisition	Powder	Colour	System
Trios®3	3-Shape, Copenhagen, Denmark	Structured light – Confocal microscopy and Ultrafast Optical Scanning™	No	Yes	Close system, Proprietary files (.DCM) available, but possibility to export .STL files via the new Trios on Dental Desktop®
Medit® i500	Identica, Seoul, Korea	Video-type scanning based on triangulation technology	No	Yes	Open system, CAD/CAM system, allowing export of STL files out of Medit LINK

Medit® scanner requires online connection to work. Even with an offline mode, the scanner can only be used offline continuously for a limited amount of time before having to be connected to the internet again. Once it is connected to the internet all scans will be uploaded to the cloud. Medit® uploading and processing times are quite long compared to Trios®. It can be said that the evaluation of the uploading and processing times are subject to the computer running and internet connection.

Medit® had no associate design software. It is purely a scanner with the software allowing control over the scan and an impressive line-up of evaluation tools. In the other hand, Trios® users not only need costly software subscription but also struggle with its instability issues causing occasional crash or file corruption. Furthermore, Trios® is a video scanner whereas Medit® is a blue light scanner. The result of a prior experiment showed no significant difference in accuracy between the intraoral video scanner and blue-light scanner data. At the same time, an intraoral video scanner and blue-light scanner showed a similar pattern of deviation (Jeong et al, 2016).

Medit®'s scanner weight is 280 g. while Trios®'s scanner weight is 340 g. Clearly, Medit®'s is 60 g. lighter than Trios which makes it easier to handle.

Trios® uses confocal microscopy technology functions by projecting onto a point and captures with specific projection. Anything closer or further than the focused point will not be captured. This technology is useful for producing optical slices of an object at various depths with high resolution. While Medit® uses triangulation technology, composed of 3-camera pattern in order to capture 3D imagery. The triangulation technology is useful because of its ability to acquire high-speed data from delicate materials such as wet materials, etc.

Regarding the scanner design, confocal microscopy composed of a moving component that helps capture the 3D imagery. To illustrate, that specific moving component may wear out one day, and it is expensive to be replaced. Therefore, scanners with triangulation only have fans as its sole moving component, it has no expensive component wearing down then there is no need for replacing.

Table 2 Additional features of Medit® and Trios®

Additional features	Medit® i500	Trios® 3
Touch screen	Not applicable as it is a USB scanner	✓
Wireless scanner	✗	✓
Caries detection	✗	✗
CAD integration	✗ Scan only	✓ Comprehensive
Subscription requirements	✓ Cloud storage does have a cost after 20 GB	✓ Required
Autoclavable tips	✓ 20 times per tip	✓ 150 times per tip

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Thus, it is important to compare their relative experience curve due to two reasons. Firstly, we cannot assume that all intraoral scanners will require the same amount of time to efficiency operate these devices. Secondly, it would be beneficial to acknowledge the differentiation of the experience curve of these 2 scanners.

Precisely, the present study aimed to compare the experience curve between 3 Shape Trios® and Medit® intraoral scanner**.**

2. Objective

To compare the experience curves between two intraoral scanners (Trios® and Medit®) among undergraduate dental students (Fifth and sixth year) and to investigate whether iterated scanning could affect scan time.

3. Materials and method

3.1 Sample size

Twelve undergraduate dental students who used Medit® and twelve undergraduate dental students who used Trios® were calculated by G*Power Version 3.1.9.3.

3.2 Materials:

Dental suction tip, Trios® 3 Color Intraoral scanner, Medit® Intraoral scanner, exploration gloves, Canon 700D and Dentoform (D18-500H (GUB)-MF)

3.3 Patient inclusion criteria

Normal mouth opening, well-aligned teeth in upper and lower arch (ALD 0-2mm), clinical absence of third molar and twenty four to twenty eight teeth

3.4 Patient exclusion criteria

Clinical presence of third molar, no visual spacing presence between teeth, history of temporomandibular disorders and presence of metal restorations in oral cavity, including crown, bridge, orthodontic bracket

3.5 Inclusion criteria of undergraduate dental student

Fifth and sixth year dental student

3.6 Exclusion criteria of undergraduate dental student

Has experience working with intraoral scanner, officially graduated from Rangsit University

3.7 Method

Before using IOS, dental students were instructed how to properly operate IOS. Each subject was required to scan in accordance with this sequence: one time in dentoform, ten times in patient, one time in dentoform. The scan time and actual time were recorded in two terms namely the actual time and scan time. Actual time represents the beginning until the end of scanning session. The scan time represents the time shown in the software.

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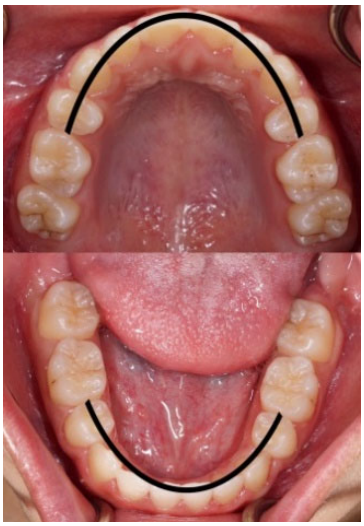

Figure 1 Occlusal line of upper arch and lower arch

The alignment of the patient's teeth was assessed before scanning. The intraoral photographs of the occlusal view of both upper and lower arch were taken and evaluated for arch length discrepancy (ALD) by experienced orthodontist. ALD at no more than 2 mm was considered well-aligned teeth.

Four patients were scanned by four undergraduate dental students, and three patients were scanned by three underagraduate dental students.

3.8 Statistical Analysis

Two types of data were collected and processed using SPSS version 24.0. The rate of decreasing actual time and scanning time was compared between two groups of dental practitioners using Trios® and Medit®. After the average scanning time per session for each group was calculated, the data were plotted as a graph to obtain an experience curve. The line representing data in the experience curve was analyzed by using t-test and repeated ANOVA, which were compared for further descriptive analysis.

4. Result

The actual time and scan time were measured in this study, and the average was calculated. The mean value of Medit® actual time from twelve sessions was 555.41 seconds whereas the mean value of Trios® actual time from twelve sessions was 477.30 seconds. The difference of mean actual time between T1 and T12 of Medit® was 313.67 seconds, while in Trios® was 369.00 seconds.

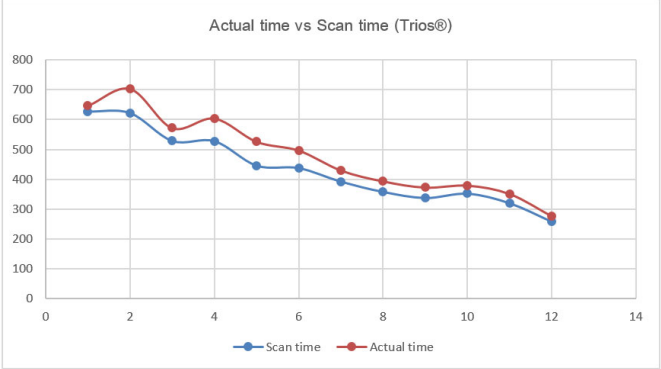

Figure 2 Comparison of actual time and scan time in Trios®

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In Medit®, the mean actual time significantly decreased between T2 and T7 (p= 0.03) , T3 and T12 (p=0.028),T4 and T12 (p=0.007), T5 and T12 (p=0.025), and T6 and T12(p=0.004). In Trios®.The mean actual time significantly decreased from T1 and T9 (p=0.013) , T2 and T9 (p=0.021) , T3 and T12 (p=0.044), T4 and T8 (p=0.043), T5 and T10 (p=0.01), T6 and T10 (p=0.007), T7 and T12 (p=0.007), and T8 and T12 (p=0.014). There was an increase in mean actual time from T1 to T2, T3 to T4 and T9 to T10 in Trios®. In Medit®, there was an increase in mean actual time from T3 to T4, and T9 to T10

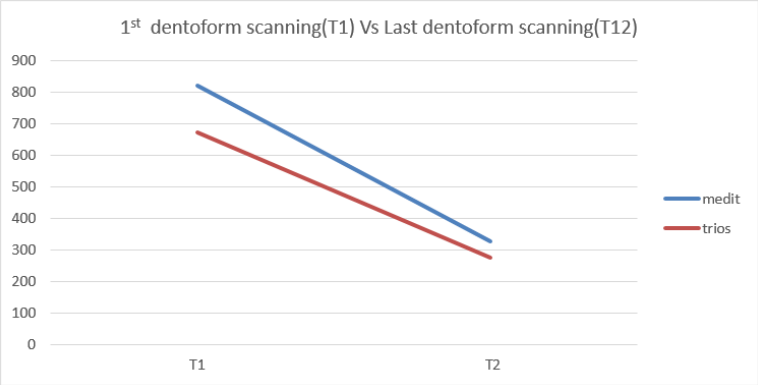

Figure 3 Comparison of 1st dentoform scanning and last dentoform scanning in Medit® and Trios®

The mean actual time in dentoform model between T1 and T12 significantly decreased after learning for both Trios® and Medit®. The mean actual time decreased by 493.17 seconds in Medit® and 369.92 seconds in Trios®. The average actual time of T2 increased in Trios®, but not in Medit®.

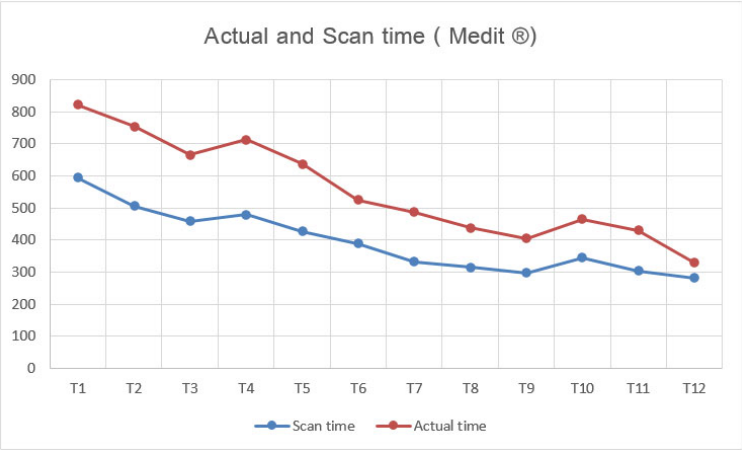

Figure 4 Comparison of actual time and scan time in Medit®

Regarding the difference in actual time and scanning time, it was observed that the mean actual time and scan time had showed a large difference in the initial scanning session, but the difference was gradually decreased throughout the experiment. The mean actual time and scan time were more or less the same in T12 in both of Medit and Trios. (Figure 3, 5)

However, the mean actual time between Medit® and Trios® in each scanning session had not shown any significant difference.

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Table 3 Regression analysis of Medit® and Trios®

		B	Std. Error	t	Sig	R square	F
Medit	Constant	826.564	31.727	26.049	0.000	0.397	93.577
	Time	-41.701	4.3111	-0.63	0.000		
Trios	Constant	710.263	27.484	25.842	0.000	0.393	92.11
	Time	-35.841	3.734	-9.597	0.000		

Regression analysis showed that R square of Medit® and Trios® was 39.7% and 39.3% respectively. The slope of Medit® (-41.701) was greater Trios® (-35.841).

5. Discussion

5.1 This study compared the experience curve between two intraoral scanners used by undergraduate dental students and determined the learning ability by investigating how repeated scanning process could affect the scan time. Most studies measured the time recorded by the scanning machine (Kim, Park, Kim, Heo & Kim, 2016) which only evaluated the information when the scanner is being operated therefore it may not reflect the actual overall time use for scanning. Our study had inspected both IOS recorded time and actual overall time to further evaluate the differences. The actual overall time was used to represent the true scanning time in our study. The average scanning time of both IOS in our study showed much shorter time than the similar study reported by Kim et al (2016). In other words, the difference in the mean value of actual time may occur due to the different inclusion criteria since our study tried to control the homogenous of the samples and include only the patients with well-aligned teeth. Hence, shorter scanning time can be expected in our study.

5.2 Surprisingly, the result between T1 and T2 in Trios® also slightly increases, considering T1 was performed in dentoform, which has less patient factor so it has lower actual time than T2. However, a decrease in time could still be achieved through repeated actions and learning lessons.

5.3 The difference between average of actual time and scan time appeared to be broad in the first few scanning sessions, this could reflect the wasted time occurs from the not operating scanner throughout the scan session which was not recorded by the machine. On the other hand, it is possible that the dissimilarity that had decreased to almost no difference in the last scan session happened because the operators became experienced with utilizing the scanner therefore they can effectively operate the complete scan afterward.

5.4 The gap of scanning days had been reported to affect the learning experience and had highlighted the forgetting effect by the increase scan time as the scanning session was not constantly continued. This factor was taken into consideration in this study, thus our scanning sessions were set to no more than one day apart. However, our resulted showed augmentation between some scanning sessions but it was not statistically difference in both scanning machines.

5.5 The subjects recruited in this study were undergraduate dental students while dental hygienists were selected for the previous study because the primary user for the scanning machine still unclear and there is no dental hygienist available in private practice in Thailand. Therefore, the subjects were limited to the dentist group. We selected undergraduate dental students since their clinical experience was expected not to alter the scanning experience curve as reported in previous study by Kim et al, (2016).

5.6 Based on the experience curve plotted in our study, it was found that there was still a decrease in actual time, which indicates that it may require more scanning sessions in order to analyze a plateau of the scanning experience curve.

5.7 The initial inclusion criteria for the number or present teeth was set to 28 teeth. However, the patient that fitted these criteria and had well-aligned teeth were too difficult to recruit. Our study had decided to fulfill the amount of patients by extending the inclusion criteria to both 24 and 28 teeth patients. In addition, result had not shown any significant difference among those patients.

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5.8 R square indicates the size of effect of one factor on another. The larger value of R square explained the more one factor has an impact on another factor. In this case, Medit® showed higher impact on learning experience than Trios®. This also correlated to the gradient of Medit® which was steeper than Trios®. It can be inferred that Medit® has higher learning rate than Trios®.

5.9 However, the effect size of this study was 1.2. The conclusion of this study may only apply to a small group of people, which referred fifth and sixth year undergraduate dental students in this case.

5.10 The error of the machines in both hardware and software were found to affect the scan time. The problems were varied according to the long scanning session and error in the programs. Based on researcher experience, Trios® seemed to give smoother scanning session which could be from the higher hardware specifications.

5.11 The learning rate in term of reaching significant difference decrease in the mean value of the actual time was found to be faster in Medit® at T7 compare to T9 in Trios®. It was assumed that different types of the scanner's handle could indicate the efficiency of the scanner usage. The pen-gripped of Medit® seemed to be more appropriate for full-mouth scanning. However, this factor requires more controlled and further experiment.

6. Conclusion

Based on the results of this study, it was concluded that actual time and scan time decreased after iterated scanning with both Trios® and Medit®, and there was an increase in proficiency. The learning rate for Medit® was faster, although the average actual time for Medit® was greater than Trios®. There was slightly difference between experience curve of Medit® and Trios®.

7. Acknowledgement

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Lastly, researchers hoped that this research will l be useful for those who are interested.

We would like to convey all merits to all the faculty members who gave the knowledge, support and cooperation to bring this research successfully.

Any mistakes that may occur at this time, the research team would like to express our apologies and are willing to accept any criticisms and suggestions from everyone who finds this study beneficial for their research in the future.

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