# Comparison of experience curves between 3 Shape Trios® and Medit® intraoral scanner

Sirawish Lertchatripong*, Nattapoom Panchon, Thanasith Pongsiriyakul, Thunnichar Hanlerdrit, Porkaew Punsriroj and Apiradee Maneenacarith

College of Dental medicine, Rangsit University, Pathum Thani, Thailand
*Corresponding author; Email: sirawish.s@rsu.ac.th

**Abstract**

Objective: To compare the experience curves between two intraoral scanners (Trios® and Medit®) among undergraduate dental students (Fifth and sixth year) and 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, The actual time and scan time. The scan time represents as the time was shown in the software. Actual time represents the begining untill finishing of scanning session.

Result: The average actual time for twelve sessions was greater with Medit® than Trios®, but a greater decrease in average actual time was observed in Medit®. The learning rate of Medit® was not influenced by patient factor, though Trios® was affected.

Conclusion: The learning rate for Medit® was faster, but the average actual time for 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 sends back to the sensor forming point cloud. Then point cloud was processed by scanning software in the form of triangular data which is then used to make the surface of the 3D-object.

IOS is gaining popularity among the users. The utility of IOS has been widely applied in many fields of dentistry including prosthodontics, restoratives, orthodontics, etc. It helps eliminate the limitations 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 completely new 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 short scan time, some dentists, especially orthodontists who need to do a complete full-mouth scan, may hesitate to step forward from conventional impressions to digital scanning.

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

Although IOS were introduced by western-country, in 2000 Identica company in South Korea had released the newcomer IOS, Medit i500. Even though there are still limited studies about it, many clinicians claim that it provides a function and scan experience that rivals some of the top scanners on the market with only for a fraction of price.

**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 an online connection to work. Although it has 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 are uploaded to the cloud. This means that uploading and processing times can be quite long compared to Trios® due to the uploading time. This does depend on the computer running and internet connection.

Medit® had no associated 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 need software subscription which is quite costly and still having some issues with stability causing the occasional crash or file corruption.

Trios® is a video scanner, while Medit® is a blue light scanner. The result of a prior experiment showed no significant difference in accuracy was found between the intraoral video scanner and blue-light scanner data and that an intraoral video scanner and blue-light scanner showed a similar pattern of deviation. **(**Jeong et al., 2016)

Medit®'s scanners weight is 280 g. while Trios® is 340 g. In comparison, Medit®'s is 60 g. lighter than Trios which make it easier for handling.

Trios® uses confocal microscopy technology which works by projecting onto a point and captures that specific projection. Anything closer or further than the focused point is not captured. This technology is great when it comes to 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. What makes triangulation useful is its ability to acquire high-speed data from delicate materials, such as, wet materials.

Regarding the scanner design, confocal microscopy composed of a moving component that helps capturing the 3D imagery. However, scanners using triangulation have no other moving component besides fan. With moving components, there is eventually a wear and tear of the piece which would then need to be replaced. That specific component may be costly or a difficult to replace. In the other hand, a scanner using triangulation, have no components 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 |

Therefore, it is important to compare their relative experience curve. We cannot assume that all intraoral scanners will require the same invest time to efficiency use these devices, and it would be beneficial to see how the experience curve compare between these 2 scanners.

With this in mind, 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 determine 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 Undergraduate dental student Inclusion criteria

Fifth and sixth year dental student

3.6 Undergraduate dental student Exclusion criteria

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

3.7 Method

Before using IOS, dental students were being instructed on steps on using IOS. 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. The actual time and scan time. The scan time represents as the time was shown in the software. Actual time represents the beginning until finishing of scanning session.

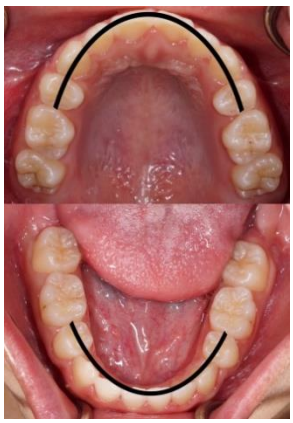

**Figure 1** Occlusal line of upper arch and lower arch

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. The well-aligned teeth was defined as ALD at no more than 2 mm..

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 was 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, and then compared for further descriptive analysis.

## 4. Result

The actual time and scan time was measured in this study, and the average was calculated. Mean actual time from twelve sessions in Medit® was 555.41 seconds. Mean actual time from twelve sessions in Trios® 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.

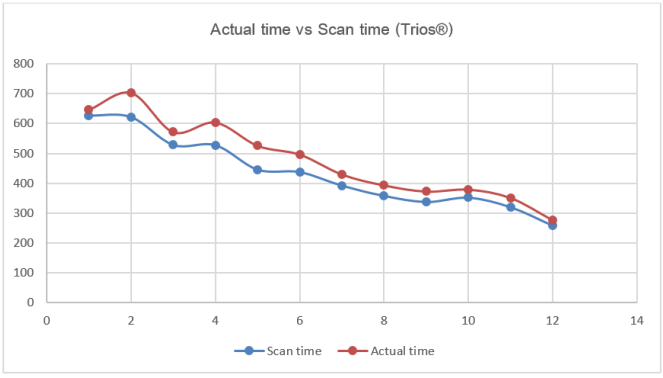


**Figure 2** Comparison of actual time and scan time in Trios®

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

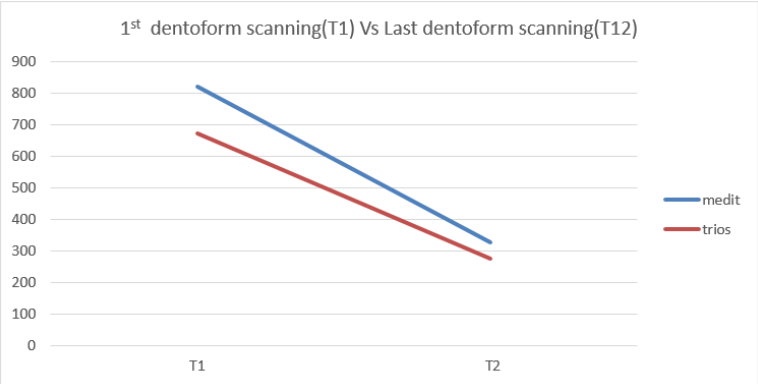


**Figure 3** Comparison of 1st dentoform scanning and last dentoform scanning in Medit® and Trios®

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®.

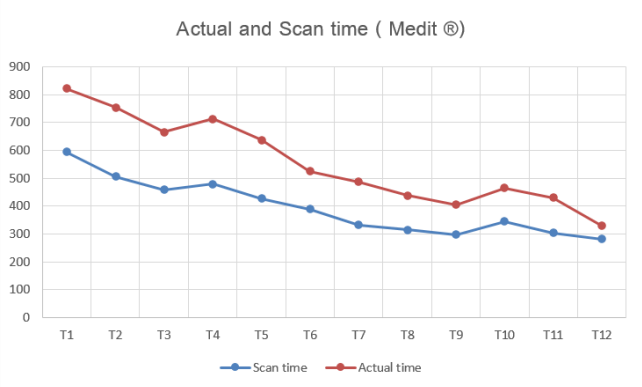


**Figure 4** Comparison of actual time and scan time in Medit®

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 through 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.

**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 determine the learning ability by investigating how repeated scanning could affect the scan time. Most of the studies measured the time recorded by the scanning machine (Kim, Park, Kim, Heo, & Kim, 2016) which count only when the scanner is operating. This 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 difference. The actual overall time was used for representing the true scanning time in our study. The average scanning time in both IOS in our study showed much shorter time than the similar study reported by Kim et al., (2016) the difference in mean actual time may be due to the difference of the inclusion criteria which our study tried to control the homogenous of the samples and include only the patients with well-aligned teeth so shorter scanning time can be expected in our study.

5.2 Interestingly, the result between T1 and T2 in Trios® also has slightly increase. This may be because T1 was performed in dentoform, which has less patient factor, has lower actual time than T2. However, a decrease in time could still be achieved from repeated actions and learning takes place.

5.3 The difference between average actual time and scan time was appeared to be large for the first few scanning sessions, this could reflect the wasted time occur from the not operating scanner throughout the scan session which not recorded by the machine. On the other hand, the difference that had decreased to almost no difference in the last scan session may be because the operators had gained their experience in utilizing the scanner and make the scanner to effectively operate all the time through the complete scan.

5.4 The gap of scanning days had been reported to effect the learning experience and had shown the forgetting effect by the increase scan time as the scanning session was not constantly continued. Our study had concerned in this regard, thus our scanning sessions were set to not more than one day apart. However, our resulted showed increasing between some scanning sessions but it was not statistically difference in both scanning machines.

5.5 The subjects recruited in our study was undergraduate dental students which different to previous study using dental hygienists. The reason was that 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 focused and limited to the dentist group which we used undergraduate dental students as clinical experienced was considered to not influenced the scanning experience curve as reported in previous study by Kim et al., (2016)

5.6 From the experience curve plotted in our study, it was found that there was still a decrease in actual time, which indicates that it may need 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, our result had not shown any significant difference among those patients.

5.8 R square indicates the size of effect of one factor on another consequences. The larger value of R square explained how much does one factor has an impact on another. In this case, Medit® showed higher impact on learning experience than Trios®. This also correlated to the gradient of Medit® was steeper than Trios®, that mean that Medit® has higher learning rate than Trios®.

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

5.10 The error of the machines in both hardware and software were found to affect the scan time and the problems were vary according to the long scanning session and error in the programs. By 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 mean actual time was found to be faster in Medit® at T7 compare to T9 in Trios®. This was assumed to be due to the different in the handle type of the scanner which the pen-gripped (Medit®) seemed to be more appropriate for full-mouth scanning. However, this factor needs to be more controlled and further investigated.

## 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, but the average actual time for Medit® was greater than Trios®. There was slightly difference between experience curve of Medit® and Trios®.

## 7. Acknowledgement

We would like to express our deep sincere gratitude to our research supervisor, Dr. Dhip Sirawish Lertchatripong as a research consultant who gave the advice, improved various imperfections, supported the data collection and all facilitations. The researchers realized his strong intention and contributions to this research. It was an honor to work and study under his guidance. We really appreciate that.

We are also deeply grateful for Miss Wiratda Janthapik, Product Specialist/Equipment Brand Manager of Leader Products Co.,Ltd. who provided the Intraoral Scanner Medit® to use in this research including the training of the usage and good maintenance.

Lastly, researchers hoped that this research will be useful more or less 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.

For any mistakes that may occur at this time, the research team would like to apologize for it and is willing to accept any criticisms and suggestions from everyone who will come to study to be beneficial for next research in the future.

The funding support for this research was from Rangsit University in year of 2019. [COA. No. RSUERB2019-041]

**8. Reference**

Ahn, J., Park, A., Kim, J., Lee, B., & Eom, J. (2017). Development of Three-Dimensional Dental Scanning Apparatus Using Structured Illumination. *Sensors*, *17*(7), 1634.

Burzynski, J. A., Firestone, A. R., Beck, F. M., Fields, H. W., & Deguchi, T. (2018). Comparison of digital intraoral scanners and alginate impressions: Time and patient satisfaction. *American Journal of Orthodontics and Dentofacial Orthopedics*, *153*(4), 534–541.

Hack, G. D., & Patzelt, S. B. M. (2015). Evaluation of the Accuracy of Six Intraoral Scanning Devices: An in-vitro Investigation. ADA Professional Product Review, 10(4), 1–5.

Jeong, I.-D., Lee, J.-J., Jeon, J.-H., Kim, J.-H., Kim, H.-Y., & Kim, W.-C. (2016). Accuracy of complete-arch model using an intraoral video scanner: An in vitro study. The Journal of Prosthetic Dentistry, 115(6), 755–759. doi: 10.1016/j.prosdent.2015.11.007

Kim, J., Park, J.-M., Kim, M., Heo, S.-J., Shin, I. H., & Kim, M. (2016). Comparison of experience curves between two 3-dimensional intraoral scanners. *The Journal of Prosthetic Dentistry*, *116*(2), 221–230.

Mangano, F. G., Hauschild, U., Veronesi, G., Imburgia, M., Mangano, C., & Admakin, O. (2019). Trueness and precision of 5 intraoral scanners in the impressions of single and multiple implants: a comparative in vitro study. *BMC Oral Health*, *19*(1).