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INTRODUCTION

There is an increased demand nowadays among orthodontic patients for an alternative treatment that is more aesthetic and comfortable ([1]). Clear aligners were introduced recently as a treatment option to fulfil the patient's demands, as they provide a number of advantages, such as being more comfortable with less pain, keeping the aesthetic appearance of the patient during the period of treatment, requiring fewer emergency visits that are scheduled for rebounding of brackets, and allowing for oral hygiene maintenance when compared to conventional methods of orthodontic treatment ([2]). For most clinicians, the biggest challenge with getting started with in-office clear aligners is selecting software to create treatment setups. Software options can vary with features and functionality, and doctors must decide carefully what features they require in software. Many of the software options require monthly subscription fees or pay-per-case export fees, and it is important to select software that will be cost-effective and functional for the office. The software that generates the CAD data is the secret to a digital system. With all of these choices, the software's user interface becomes a crucial deciding factor. The user experience varies for every piece of software you use, including the operating system, word processor, email, and browser. System requirements, software support, usability, learning curve, portability, replication, and ease of use are all important factors. For instance, a CAD program that can only be used with high-end hardware differs greatly from one that is cloud-based and accessible via any device, including a smartphone. Orthodontists must scale the portability of CAD data into at least every operatory in the clinic unless they operate a digital lab. Some clear aligner systems require the installation and use of a native software platform that is not cloud-based and has very demanding hardware requirements. The environment that this software resides in is another crucial aspect because it will be integrated. How easy, for instance, is the transition from digital impression capture to CAD design? The export features that provide image data will be present in every digital scanner as more of them become available. Using different software platforms can have an impact on compatibility and efficiency. Each aligner has a built-in computer program that moves a tooth or small group of teeth 0.25 to 0.33 mm every 14 days. [(3)].

MATERIALS AND METHODS:

Aligner fabrication and software management:

Pre-treatment study models were recruited from the Out-patient's clinic of orthodontics at the faculty of Oral and Dental medicine, Future university, Cairo. Egypt. These models were filtered and eligibility criteria were applied to ensure the models were qualified to be included in the study.

a) **Eligibility Criteria**:

Inclusion Criteria:

1- Age: between 11 – 30 years old.
2- Sex: males or females.
3- Mild crowding.
4- Non- extraction cases.

Exclusion Criteria:

1- No possible restorable teeth.
2- Teeth showing attrition.
3- Patients with missing upper first permanent molars.
4- Patient with complicated cases or severe crowding.

b) Steps done by each assessor on the aligner software:

1. Digital impression acquisition for teeth.

For creation of digital model for teeth, digital acquisition for teeth was accomplished using Intraoral scanner (Medit i500, Seoul, Korea). Acquired dental virtual models were exported to Standard tessellation language format (STL) (Fig.1). The produced STL files were imported into the orthodontic planning software evaluated to perform planning procedures according to the manufacturer's instructions

2.Orthodontic Planning process.

Orthodontic planning for fabrication of clear aligners was performed according to the manufacturer instructions of each software.

Materials (software) used in the study:

Four different orthodontic planning software used for planning clear aligners cases were used in this study. Software used and evaluated in this study are listed in table (1)

All software have same processing steps but with different interfaces and icon arrangements as follows:

1. Transferring patient data. (Fig.1)
2. Trimming of models. (Fig.2)
3. Adjusting orientation of the models. (Fig.3)
4. Dental model analysis. (Fig.4)
5. Moving teeth & teeth segmentation. (Fig.4)

Clear aligner designing & building tool. (Fig.6)

II. Software evaluation by:

1. Scoring template (Table .2 scoring template)

III. Detailed steps for the clinician experience and evaluation (Fabrication Process):

1. Ten orthodontists were recruited for the evaluation process.
2. A total of 48 casts were used including upper and lower arches for each case.
3. To verify the reliability of the scanner, we scanned the reference models 2 times before integrating the image into the 4 software.
4. Each orthodontist made a check mark on each option in the checklist.
5. A check mark with **YES** was given a One point, and a check mark with **NO** was given Zero point.

STATISTICAL ANALYSIS:

Categorical data were presented as frequency and percentage values. Numerical data were presented as mean and standard deviation values. They were analyzed for normality using Shapiro-Wilk test and they were found to be non-parametric. They were analyzed using Kruskal-Walli's test followed by Dunn's post hoc test with Bonferroni correction. The significance level was set at $p \leq 0.05$ within all tests. Statistical analysis was performed with R statistical analysis software version 4.1.3 for Windows[1].

RESULTS

Descriptive data:

Descriptive data were presented in tables and in figures. (Fig.7), (Table.3)

- **Romexis 3D Ortho Studio:**
  For questions (1), (2), (4) and (5) majority of respondents chose" Yes" while for question (3) they chose "No".

- **Blue Sky Plan 4:**
  For questions (1), (2) and (3) all of

  respondents chose" Yes" while for questions (4) and (5) all of them chose "No".

- **3SHAPE:**
  For questions (1), (2), (3) and (4) majority of respondents chose" Yes" while for question (5) they chose "No".

- **Maestro 3D Dental Studio Order Management V5:**

For questions (1), (2), (4) and (5) majority of respondents chose" Yes" while for question (3) they chose "No".

Discussion

One of the challenges for dental practitioners is finding suitable software for designing dental aligners in clinical practice, which have now been established as a treatment option for many cases [4].

Orthodontists now employ a more aesthetically pleasing treatment modality due to patient demand for aesthetic treatment alternatives. Clear aligner therapy is one procedure that can be used in place of conventional bracket and arch wire systems. (CAT).

The advancement of scanning, CAD software and 3D printing has led to the creation of in-office digital orthodontics. Orthodontists now create aligners without the need to outsource their production. Cost-saving in-office aligner manufacturing enables orthodontists to alter treatment plans based on patients' clinical reactions. Clear aligners have gained great popularity throughout the years, many factors command the success of the treatment outcome. Aligner material, staging of tooth movement, attachments on teeth, integration of inter-arch elastics and interproximal reduction. So, this study aimed to assess the functionality of the major, most-used digital orthodontic software for planning clear aligner cases. The aim of the study was to evaluate different types of in-office clear aligner software, not for which had the best production or results, but for to have more information about the user experience or the process of the software itself. Also, the first to make a technical template for the doctors in a simple way revealed major differences between software options. Accordingly, doctors would have no need now to experience each software by itself having major and important information from this template before using any software

Assessment criteria for assessment were selected according to studies *by* ***Seto etal in 2017 & Jackson etal in 2011,*** where criteria for software evaluation were set in these studies including: flexibility, sophistication of steps, output quality, usability & buildability regarding whether the software is straightforward or not [5].

The accuracy of clinical outcomes for clear aligner cases is much related to the manufacturing process of clear aligners of which an important step is the acquisition of digital models. For this reason, an intraoral scanner with high accuracy was used to produce highly accurate virtual models [6]. Studies *by* ***Logozzzo etal in 2008, Karvitz etal in 2014 and Mangano etal in 2017*** stated that intraoral scanners even with different scanning technologies are reliable regarding the production of three-dimensional models with high accuracy, that could be used to produce clear aligners with predictable clinical outcome [7,8,9].

Multiple software packages are present in the market that are dedicated to digitally designing orthodontic aligners; these packages vary not only in their prices but also in their functionality and ease of use by orthodontists. Dedicated digital orthodontic software were selected in our study as Planmeca, BlueSky, and 3D Maestro. The reason for their selection is that they are the most widely used commercial software in digital orthodontics planning and production of clear aligners, where they provide dedicated tools for evaluation of cases and planning of required preparation steps for cases prior to starting the treatment, such as the need for extraction or interproximal reduction. Other open-source, nonspecialized software were not selected in the current study because, despite their low cost and ease of use, they don’t contain dedicated tools for orthodontic planning [10].

CONCLUSION

According to the results of the current study, the following conclusions could be drawn:

1. There were no significant differences in tools and options regarding the software
2. The BlueSky bio showed easiness in manipulation and work flow due to arrangement of tools and options
3. Romexis 3D Ortho Studio has shown the highest results, indicating it was the most time consuming among the tested software.
4. Maestro 3D Dental Studio order management was the most complex among the tested software.
5. There was no statistically significant difference regarding achieving the aims of the software and their reliability.

LIMITATIONS AND RECOMMENDATIONS

In this study digital planning inside the digital orthodontic software depended only on the STL obtained from scanning of models, other studies relied on integration of cone beam tomography CBCT with STL files, which could add more steps and time for orthodontic planning process, but it has an impact on the overall accuracy of the treatment outcome for clear aligners obtained from digital planning [11,12,13,14,15].

This study is a pioneer regarding its outcome in assessment of the clinical orthodontic practitioner's user experience when dealing with orthodontic planning software. The results of this study could be beneficial in the enhancement and development of the user interface in such software resulting in an easier and more time efficiency in planning and production process of clear aligners.

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Software	Manufacturer
Romexis 3D Ortho Studio	Planmeca Oy, Helsinki, Finland
Blue Sky Plan	Pmdi Europa GmbH, Langenhagener, Germany
Maestro 3D Dental Studio V6	AGE Solutions, Pisa, Italy
3shape Ortho system	3Shape, Copenhagen, Denmark

Table .1 showing 4 software used

SCORING		
Are the aims of the software and achieved?	□ Yes	□No
Is the software reliable?	□ Yes	□No
Is the workflow of the software user friendly	□ Yes	□No
Is it time consuming?	□ Yes	□No
Is it a complicated software?	□ Yes	□No

Table .2 showing scoring template

Question	Scores (mean±SD)				p-value
	Romexis 3D Ortho Studio	Blue Sky Plan 4	3SHAPE	Maestro 3D Dental Studio Order Management V5	
Are the aims of the software and achieved?	0.82±0.40^{A}	1.00±0.00^{A}	1.00±0.00^{A}	0.64±0.50^{A}	**0.053ns**
Is the software reliable?	0.91±0.30^{A}	1.00±0.00^{A}	1.00±0.00^{A}	1.00±0.00^{A}	**0.392ns**
Is the workflow of the software user friendly?	0.18±0.40^{B}	1.00±0.00^{A}	0.73±0.47^{AB}	0.18±0.40^{B}	**<0.001***
Is it time consuming?	1.00±0.00^{A}	0.00±0.00^{B}	1.00±0.00^{A}	0.91±0.30^{A}	**<0.001***
Is it a complicated software?	0.64±0.50^{AB}	0.00±0.00^{B}	0.27±0.47^{AB}	0.82±0.40^{A}	**<0.001***

Table .3 showing Mean results between 4 software

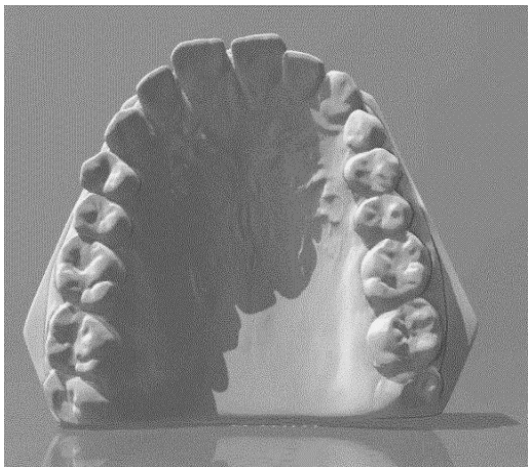

Fig.1 showing stl scan

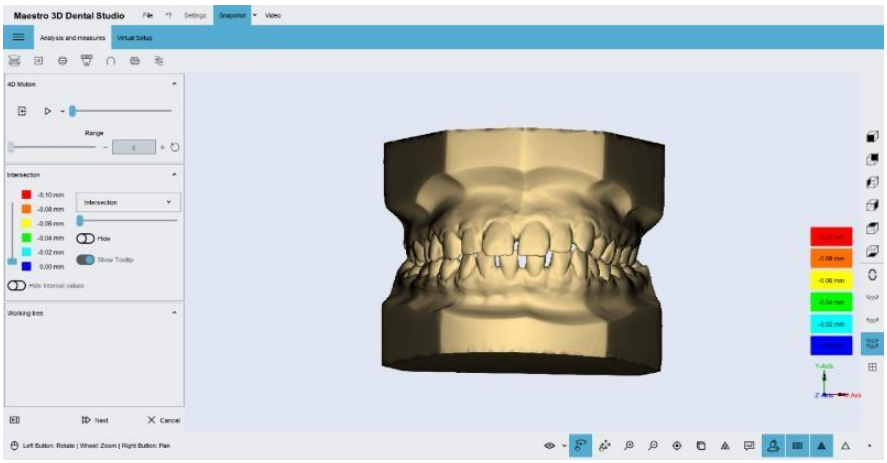

Fig.4 showing dental model analysis

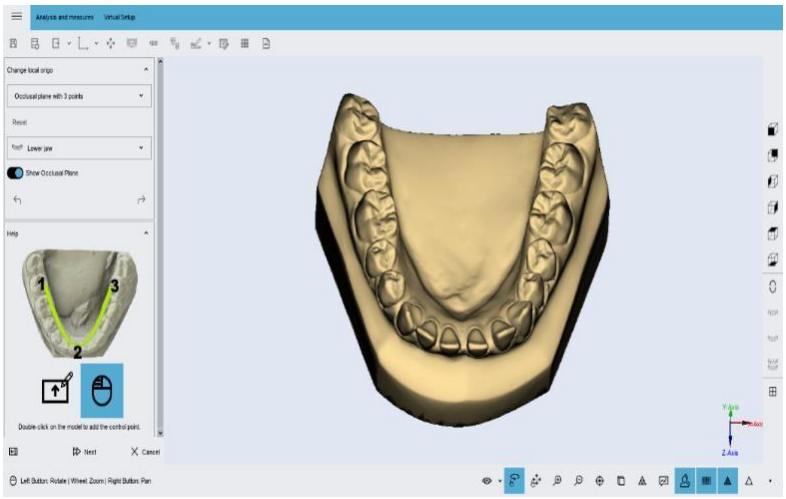

Fig.2 showing model trim tool

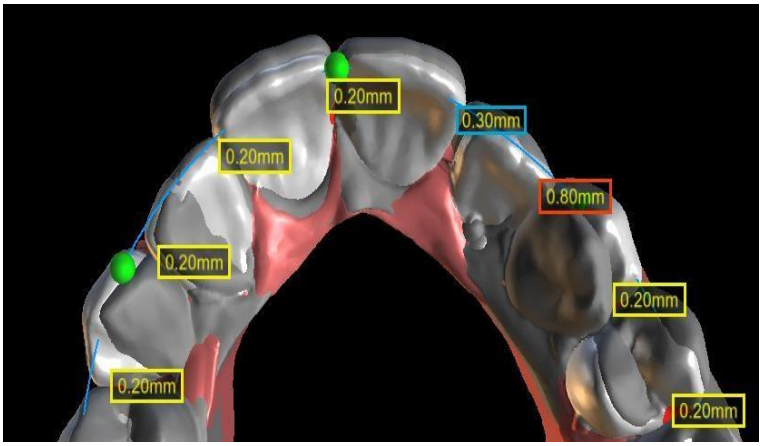

Fig.5 showing teeth segmentation and moving of teeth

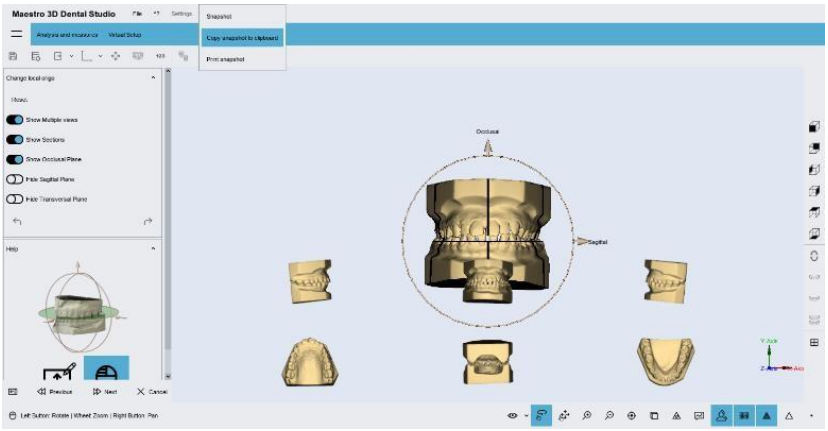

Fig.3 showing orientation of models

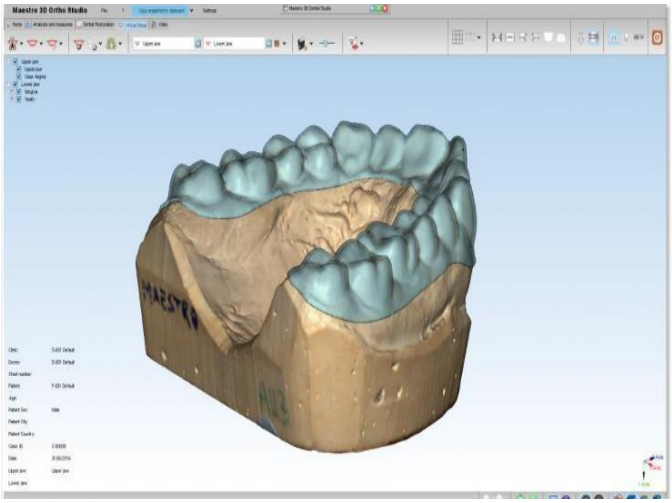

Fig.6 showing Clear aligner builder tool

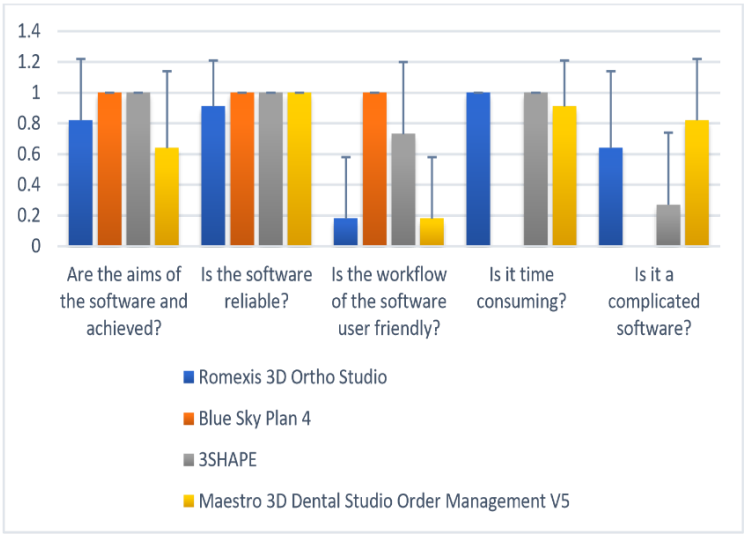

Fig.7 showing Bar chart for Mean results between 4 software