Original Article

To study the predictability of a digital Keslings setup: A Pilot study

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Abstract

Background: The diagnostic setup proposed by H.D. Kingsley serves as a practical aid in treatment planning and diagnosis. Virtual setups, also known as the virtual Keslings setup, are a new development in dentistry and orthodontics. As there is very limited literature available on this topic, the purpose of this pilot study was to calculate the accuracy of the predicted treatment outcome achieved by using the Digital Keslings setup when compared to the final treatment outcome achieved clinically.

Materials and Methods: 25 Subjects with bimaxillary proclination, who were to be treated with all 4 first premolar extraction, were selected for the study. The pre-treatment intraoral scans of all 25 patients were taken using the 3Shape - Trios 3 intraoral scanner. A digital keslings setup was performed using these digital models, on the 3Shape Orthoanalyser to predict the final treatment outcome. Measurements were made on this final predicted model. Following this, the treatment was started by the Orthodontists. The treatment plan employed in Kesling's prediction was used to treat the patients in the study After the treatment was completed, an intraoral scan kept all the previous parameters constant. These post-treatment scans were again uploaded on the 3 Shape Orthoanalyser software. These scans were superimposed on the models on which the Keslings setup was performed and the amount of discrepancy was noted between what was predicted and what was finally achieved post-treatment to see the accuracy of the Keslings setup.

Results: A statistically significant difference was noted between what was predicted using the digital Keslings setup and what was achieved clinically in relation to The intermolar distance, intercanine distance, and angle of the long axis of 11 that were predicted virtually were more than what we achieved clinically and the A-P distance planned virtually was more than what was achieved Clinically – suggesting a greater amount of retraction being achieved clinically than virtually.

Conclusion: The digital Kesling setup is a boon in dentistry. It helps us to plan treatment and visualize the outcome however the results that we obtain using Kesling's setup were statistically different from that of values obtained clinically. Thus, we can conclude that a keslings setup cannot accurately predict the treatment outcome.

Keywords: Herbal medicine, Drug-Interactions, Cytochrome P450, Metabolism, Docking.

Introduction

The diagnostic setup proposed by H.D. Kingsley (1)(2) serves as a practical aid in treatment planning and diagnosis. Virtual setups, also known as the virtual Keslings setup, are a new development in dentistry and orthodontics.

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Access this article online

Quick Response Code:

Website: www.pnrjournal.com

DOI: 10.47750/pnr.2022.13.04.249

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How to cite this article: Niharika B., Navaneethan R., To study the predictability of a digital Keslings setup: A Pilot study, J PHARM NEGATIVE RESULTS 2022;13(4): 1814-1818.

The manual keslings setup is a laborious process but can be a boon for complex cases where treatment planning is difficult. The keslings setup is a procedure done on plaster models and involves individualizing the teeth and rearranging them in the required position in order to finalize the treatment plan. Blades are used in the individualization of the teeth in the models. (2) This cutting of teeth on the models leads to tooth material loss, which hampers the accuracy of the tooth fit. Dental models provide a great deal of information on the mesiodistal dimensions of teeth, arch length discrepancies, dental asymmetries, and arch relationships in three dimensions. A dental model can also be used to produce a 3D simulation of a treatment plan. A digital version of this diagnostic setup is called the virtual setup, which helps us perform the same functions that we do in the manual method, however, as there is no loss of the tooth structure during the cutting of the teeth, the ultimate prediction is more accurate than the manual method (3)(4) Through these simulations, potential therapeutic objectives such as the need for tooth extractions or interproximal stripping can be evaluated. Since the digital setup provides more accuracy, treatment plans become less speculative, resembling a real treatment and providing orthodontists with reliable information along with making the process less messy and tedious.(3) (4) In the current study, we have used the digital version of the same keslings setup to plan the treatment. The aim of this study is to thus analyze the accuracy of treatment outcome prediction performed using the digital Keslings setup.

Materials and Methods:

The pilot study was started at the department of orthodontics and dentofacial orthopedics, Saveetha Dental College and hospital, Chennai. The sample size for this pilot study was decided to be 25 subjects. The inclusion criteria were both male and female subjects between the ages of 18-40 years with full natural permanent detention, and bi-maxillary proclination, with a maximum crowding of 4-5mm (5) who are to be treated with first permanent premolar extraction. All patients in the OPD were screened by a single observer, for bimaxillary proclination, meeting the inclusion mentioned above criteria. Before treatment was started, a complete intraoral scan was taken for every individual subject using the 3- shape Trios 3 basic intraoral scanner. These intraoral scans were then transferred to the 3-Shape Orthoanalyzer software version 2021.1. The Digital Keslings setup was then performed on these pre-treatment digital models, where the upper and lower first premolars were virtually “extracted” and the teeth were re-positioned in the desired position to achieve, an Angle’s class 1 molar relationship, class I canine relationship, an ideal overjet, ideal overbite and proper axial inclination of the incisors. The final result achieved was a prediction of the expected final treatment outcome. Post performing the digital Keslings setup, and keeping the prediction in mind, the treatment was started using the MBT bracket 0.022 prescription and friction mechanics, to achieve the ideal treatment objectives. After the entire course of treatment was completed, the brackets were debonded and polishing of the teeth was done. The post-operative intraoral scans were taken and digital models were obtained using the same scanner. These digital scans were then transferred to the 3 Shape Orthoanalyzer software to perform the comparative analysis. 5 Measurements were recorded namely, a)Intermolar distance (measured from the mesial pit of the first permanent molar on the left to the first permanent molar on the right), b) Inter 2nd premolar distance (measured from the buccal cusp tip of the premolar on either side), c) inter canine width (measured from the canine cusp tips of one side to the canine cusp tip on the other side), d) the A-P distance from the center of the incisal edge to the transverse line joining the first molars and e) the axial inclination of the central incisor to the occlusal plane. The measurements were performed on both, the pre-treatment models post-Kesling setup and the post-orthodontic treatment digital models. The values obtained were tabulated on an excel sheet. To further improve the accuracy, the post-treatment scans were superimposed on the models achieved after performing the Keslings setup to quantify and analyze the discrepancy between what was predicted digitally, and what was achievable clinically.

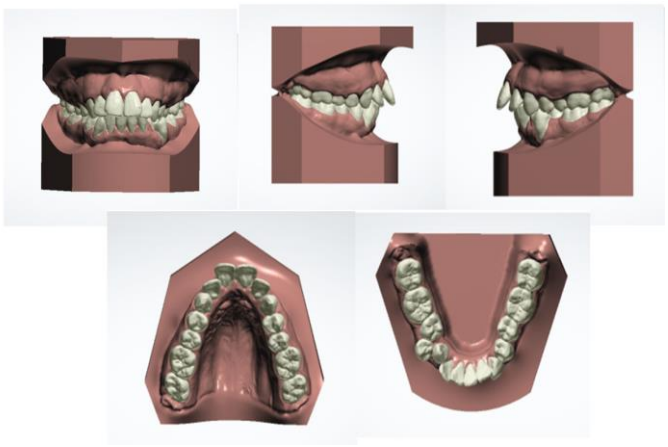

Fig 1: Pre-treatment models of a patient with bidental proclination

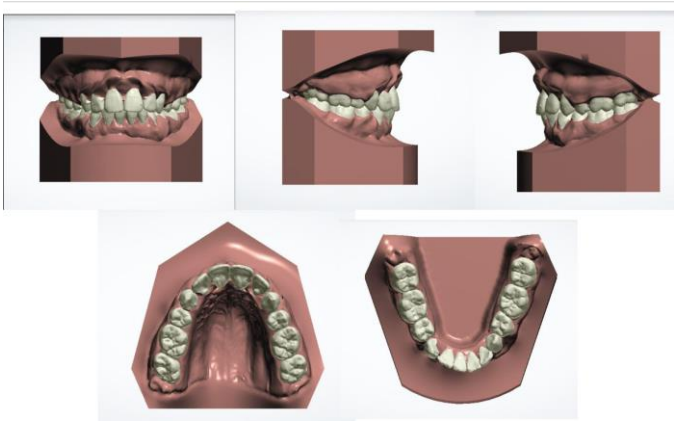

Fig 2: The predicted treatment outcome using a virtual keslings setup

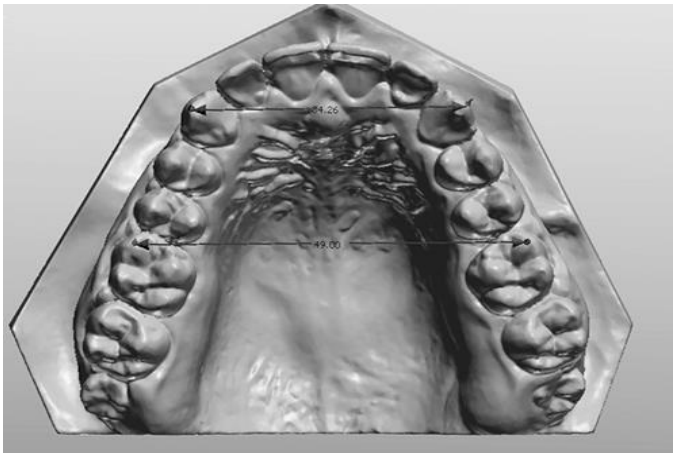

Fig 3: The intermolar and intercanine distance being measured in the Transverse plane.

Statistical Analysis:

The data for each group were calculated and tabulated in Excel. This data was exported to the statistical analysis software where the statistical analysis was performed using the IBM SPSS 23 software. The values achieved were tabulated in Microsoft Excel in 2 columns - one after performing the keslings setup and the other values achieved post-treatment. These values were then transferred to the SPSS software where first, the normality testing was done keeping the $p<0.05$, which produced a parametric result, after which, the paired sample T-test was performed for all the 5 predicted and achieved values.

Results:

The statistical tests performed indicated that there is a statistically significant difference in what is predicated using the digital Keslings setup and what is actually achievable clinically. Thus, based on the results of this study, it is safe to say that the Keslings setup does not accurately predict the final treatment outcome and the results obtained using the setup are not reproducible clinically.

Table 1.1 shows the mean, SD, and error of the outcomes attained on the virtual Keslings setup and the one attained clinically:

PARAMETERS	Post treatment			Keslings prediction			SIG
	MEAN	SD	ERROR	MEAN	SD	ERROR	
INTER CANINE DISTANNCE	43.6	.76	.198	45.3	.67	.078	.000
INTER MOLAR DISTANCE	46.5	.869	.194	48.2	.41	.093	.000
DISTANCE FROM 11 TO LINE JOINING 6-6	38.8	.36	.08	40.7	.62	.14	.000
ANGLE BETWEEN LONG AXIS OF 11 TO OCCLUSAL PLANE	72.2	.88	.18	75.6	.98	.28	.000

Discussion:

Ever since Kesling first recommended their use in 1947, diagnostic setups have been used to simulate different treatment options and aid decision-making during treatment planning. (1) Creating multiple setups to represent different treatment plans can help when considering extraction patterns, interproximal reduction (IPR), anchorage management, and other treatment mechanics. (6) With the transition to digital study models, diagnostic setups can now be created digitally, which is more accurate and reliable than plaster and wax setups(3)(7) According to Sousa et al.(8) the digital models proved as reliable as plaster models (casts) in obtaining the measures commonly used for diagnosis. Fleming et al (9). reported that digital models offer a high degree of validity when compared with the direct measurement of plaster models, and the differences between these approaches are likely to be within clinically acceptable limits. However, there may be small differences between measurements made on plaster models vs digital models. Working with digital setups offers new advantages that were not possible with plaster, such as the ability to superimpose the setup with the original models and the ability to determine the precise amount of movement for each tooth along with the final treatment plan and tooth fit (9,10). Moreover, the program is easy to learn and manipulate, image setups are easy to store as they do not require large physical spaces, as is the case with plaster models, whose storage costs are extremely costly in many cities around the world. Finally, communication between professionals and the patient is facilitated, since setups can be sent over the Internet, avoiding potential breakage during shipping and handling. This advantage is also mentioned by some authors regarding digital models (11)(12)(13).

Although this digital setup can be seen as a byproduct of the manufacturing process, the setup actually represents an additional data point for clinicians to consider while treatment planning. Some clinicians may already generate multiple digital setups using clear aligner software when deciding between different treatment decisions. Many studies (14)(15)(16) suggest that setups have a strong impact on treatment planning, especially for more challenging cases, and software that allows setups to be created simply, quickly, and accurately, could make digital setups a routine and desirable part of the treatment planning process. Although setups are generally regarded as useful, the magnitude of the effect of these digital setups on treatment planning has yet to be quantified.

This study has thus been performed to assess the reliability of the outcome of Digital Kesling's setup when compared to the final treatment outcome achieved clinically.

This study measured the inter canine distance, intermolar distance, the anteroposterior distance between the incisal edge and the line joining the two molars, and the axial inclination of the incisors. After performing the statistical analysis, we can conclude that there was a significant difference between the treatment plan achieved using the

digital Keslings setup and the final treatment outcome achieved clinically. The mean values of all the parameters were seen to be more in the Keslings prediction, except the Antero-posterior distance from 11 to the line joining the two molars on either side which suggests that there is more distal movement in the clinical scenario. This may be attributable to the correction of some amount of proclination by tipping of the anterior teeth. The results of our study are in disagreement with the results proposed by M.Adel et al (17) and Araujo et al (13)who stated that there is a very high accuracy of predicted outcomes. This study however did not correlate the predicted outcomes with what is achieved clinically. The variations seen in the result can be attributable to multiple factors which may cause a change in tooth movement intraorally such as bone density, anchorage, muscle forces, genetic factors, and other environmental factors, which cannot be considered when performing the digital keslings setup.(18)

It is important to underline the limitations of this study which are that the natural teeth have various degrees of translucency and refraction, which alters the scanned images of the teeth through the scanner thereby altering the accuracy of the measurements made. Furthermore, intraoral conditions such as saliva and limited scan space affect the scanned images (18). There are various factors that need to be considered for tooth movement in a patient like PDL response, bone density, Individual habits, etc, and thus, the movements made on the digital setup cannot be accurately reproduced. Despite the fact that virtual setups have many advantages, the high cost of the hardware and software is one major disadvantage of performing a digital setup virtually. In this study, the program used to perform the digital setup provided poor visualization of the gum line. The gum does not follow extensive tooth movements, which hinders gum line analysis. Moreover, this study has been performed on very limited sample size and on the Dravidian population thus the results cannot be generalized.

Conclusion:

From the present in-vivo study, it follows that the null hypothesis was rejected. The following conclusions can be drawn after performing this study:

- The intermolar distance, intercanine distance, and angle of the long axis of 11 that were predicted virtually were more than what we achieved clinically.
- The A-P distance planned Virtually was more than what was achieved Clinically – suggesting a greater amount of retraction being achieved clinically than virtually.
- The digital Keslings setup can help the operator to visualize the tooth positioning and relationships.
- It is important to mention that tooth movements on computers are unlimited. Tooth alignment and leveling can be planned on the computer screen but this result may not be realistic for that specific patient. Obviously, tooth movement has its biological limitations. Therefore, too much expansion or compression of the dental arches as planned in virtual setups may result in unstable results and periodontal recessions.
- Thus, based on the results of this study, it is safe to say that the Keslings setup does not accurately predict the final treatment outcome and the results obtained using the setup are not accurately reproducible clinically. These results are in disagreement with the results obtained by M. Adel et al (17) and Araújo, T. M. D (13)

Data availability:

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of interest:

The authors declare that they have no conflicts of interest.

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