Efficacy of Smartphone Learning Versus Lecture-Based Learning for Instruction of Cephalometric Landmark Identification

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Abstract

Background: Considering the increasing popularity of electronic learning, particularly smartphone learning, and its reportedly optimal efficacy for instruction of complicated topics, this study aimed to compare the efficacy of smartphone learning versus lecture-based learning for instruction of cephalometric landmark identification.

Methods: This quasi-experimental interventional study evaluated 53 dental students (4 th year) in two groups of intervention (n=27; smartphone instruction using an application) and control (n=26, traditional lecture-based instruction). Two weeks after the instructions, dental students were asked to identify four landmarks namely the posterior nasal spine (PNS), orbitale (Or), articulare (Ar) and gonion (Go) on lateral cephalograms. The mean coordinates of each landmark identified by orthodontists served as the reference point and the mean distance from each identified point to the reference point was reported as the mean consistency while the standard deviation of this mean was reported as precision of measurement. Data were analyzed using SPSS version 18 via independent sample t-test.

Results: No significant difference was noted between the two groups in identification of PNS, Ar or Go (P>0.05). However, the mean error rate in identification of Or was significantly lower in smartphone group compared with the traditional learning group (P=0.020).

Conclusions: Smartphone learning had a comparable, and even superior, efficacy to lecture-based learning for instruction of cephalometric landmark identification, and is recommended to enhance the instruction of complicated topics.

Introduction

Effective instruction is the most important factor in academic progression and efficient learning of students. However, the method of instruction should be flexible to match the learning needs of individuals. Cooperation and interaction between students is also important in comprehending the educational content [1–3].

Recent advances in technology have revolutionized the methods of instruction at all levels. Dental education is no exception to this rule [4]. With the advances in computer science, availability of high-speed Internet and smartphones, many universities worldwide have debuted long-distance web-based learning or multi-media instruction programs [5]. Electronic learning has been shown to be superior to the traditional learning in many aspects and has highlighted the shortcomings of traditional classroom teaching [6]. As the result, electronic learning is growing fast worldwide and is gaining increasing popularity among learners and mentors. Nkenke et al. [7] showed that technologically-enhanced learning in a theoretical radiological science course decreased the need for lecture-based instruction without negatively affecting the examination results. Of different tools used for electronic learning, smartphones are highly popular among learners due to unique properties such as being user friendly, small size, the ability to connect to the Internet and easy use [8–10]. Thus, they are well suitable for instruction [11]. In fact, smartphone learning and web-based learning are the two arms of electronic learning that have greatly advanced in the recent years and are extensively used as novel techniques of instruction and learning. Considering the high popularity of smartphones, smartphone learning is easier and more accessible than web-based learning and is capable of enhancing the education [12, 13].

At present, lateral cephalometry is an important diagnostic imaging modality for detection of dentoalveolar disorders in orthodontics and orthognathic surgery. Cephalometric assessment involves landmark identification and linear and angular measurements, and is used to determine the morphology of maxillofacial structures and also for treatment planning and assessment of treatment outcome. Moreover, it is essential for diagnosis and treatment of skeletal deformities [14, 15]. Consecutive lateral cephalograms are often requested to study and predict the growth pattern, progression of orthodontic treatment and prognosis of treatment of orofacial deformities. They are also used to assess the changes caused by the intervention and evaluate the efficacy of treatment [16, 17]. However, lateral cephalometry has some drawbacks as well. For example, it has a number of internal and external confounding factors. The majority of cephalometric measurements require landmark identification and angular and linear measurements, which require high expertise [18]. Moreover, it provides a two-dimensional image of three-dimensional structures; thus, some data are lost and it requires considerable spatial visualization [19]. Therefore, dental students should acquire high proficiency in order to be able to correctly interpret lateral cephalograms [20–22]. Thus, provision of 3D images and videos can greatly help in easier and more efficient learning of this topic [15]. Moreover, considering the significance of accurate landmark identification for more precise interpretation of lateral cephalograms and subsequently more accurate orthodontic treatment planning, it is important to find a technique for more effective instruction of this topic. At present, cephalometric landmark identification is instructed to dental students via traditional lecture-based instruction. Thus, there is an obvious need to employ more advanced technologies for enhanced instruction of this topic.

Considering the gap of information on the use of smartphones for more effective education [23], this study aimed to compare the efficacy of traditional learning versus smartphone learning for instruction of cephalometric landmark identification to dental students.

Materials And Methods

This quasi-experimental, single-blind study evaluated 4th year volunteer dental students of School of Dentistry of Kermanshah University of Medical Sciences in 2018–2019. The students had passed the theoretical course of lateral cephalometry and were selected using census sampling. This study was conducted during the second semester of the 2018–2019 academic year and introduced the use of a mobile application to compare the efficacy of traditional learning versus smartphone learning for instruction of cephalometric landmark identification to dental students. Sample size was calculated to be a minimum of 26 students in each group according to a study by Silveira et al, [24], standard deviation of knowledge score to be 2.87 and 2.61 in the traditional learning and smartphone learning groups, respectively, accuracy (d) of 2.5, alpha = 0.05 and power of 90%.

The study was approved in the ethics committee of Kermanshah University of Medical Sciences (IR.KUMS.REC.1397.791). The students were ensured about the confidentiality of their information and signed informed consent forms prior to participation in the study. All the volunteers were enrolled in the study except for those who reported previous knowledge/training in lateral cephalometric landmark identification. The volunteers were informed that evaluation of their performance in this study would have no effect on their final grade in this course. The study was conducted in the Orthodontic Department by an expert orthodontist. All participants received basic theoretical training regarding lateral cephalometric analysis. The educational program consisted of 2 hours of lecture-based learning that focused on theoretical learning regarding lateral cephalometric analysis. The students were then randomly divided into two groups of intervention (smartphone learning) and control (lecture-based learning). The educational contents were the same in both groups and focused on tracing of lateral cephalograms and landmark identification.

Intervention group (n = 27): Dental students in the intervention group were provided with a smartphone application that included a 2-hour educational video clip recorded by a skillful instructor (orthodontist) regarding the following topics: (I) marking the soft tissue profile, outlining the external border of the skull and vertebrae, (II) outlining the base of skull, internal margin of the skull, frontal sinus and porion, (III) outlining the maxilla and its related structures, (IV) outlining the mandible, (V) identification of cephalometric landmarks, and (VI) drawing the anatomical planes.

Control group (n = 26): Dental students in the control group received the same educational content as did the intervention group in a classroom setting in the form of a 2-hour workshop and also received a pamphlet with the same educational content as in the smartphone application, in order to be able to review the taught topics later.

The students had 10 hours of self-study by use of the mobile app or traditional models, depending on their group allocation. Two-week time was allowed for the students in the intervention group to use the application and for the students in the control group to review the taught topics and then both groups participated in a test to assess their expertise in cephalometric landmark identification (Fig. 1). Lateral cephalogram of an orthodontic female adult patient with no cleft lip/palate, no supernumeraries, no missing, no anatomical anomalies, no severe asymmetry, no skeletal dysplasia requiring orthognathic surgery, and no use of denture or dental splint was demonstrated to dental students and they were asked to trace the cephalogram and identify four landmarks. The aforementioned four landmarks were selected by two orthodontists and one radiologist in a group discussion and included the posterior nasal spine (PNS), articulare (Ar), gonion (Go) and orbitale (Or).

PNS: The most posterior point on the sagittal plane of the hard palate on the mid-sagittal plane

Ar: A point at the intersection of the image of the posterior margin of the ramus and the outer margin of the cranial base.

Go: The outer point on either side of the lower jaw at which the jawbone angles upward.

Or: The most inferior point of the inferior border of orbit.

Lateral cephalogram was taken by Cranex 3D (Soredex, Tuusula, Finland) and printed by a laser printer (Dry view 5950; Kodak, USA) using 8 × 10 inch Kodak medical X-ray film.

The X and Y coordinates of each landmark identified by dental students were compared with the reference points identified by the orthodontists. The mean distance between the identified landmark and the reference point was calculated and reported as the mean consistency while the standard deviation of this mean was reported as the accuracy of measurement for each group (Fig. 2).

Data were analyzed using SPSS version 18 (SPSS Inc., IL, USA). Normal distribution of data was evaluated using the Kolmogorov-Smirnov test, which showed that the data were normally distributed. Thus, the two groups were compared using independent sample t-test. The Chi-square test was applied to assess the correlation of gender and study group. Level of significance was set at 0.05.

Results

A total of 53 dental students participated in this study; out of which, 27 (50.9%) were males and 26 (49.1%) were females. A total of 27 dental students were evaluated in the smartphone learning group including 13 males (48.1%) and 14 females (51.9%). Also, 26 dental students were evaluated in the traditional learning group including 14 males (53.8%) and 12 females (46.2%). The two groups were not significantly different in terms of gender (Chi-square test, P=0.678). The mean age of students was 22±1.63 years.

The mean grade point average of students was 15.39±1.09 in the traditional learning and 15.57±0.91 in the smartphone learning group. The difference in this regard was not significant between the two groups (Independent sample t-test; P=0.503).

Table 1 compares the two groups regarding errors in identification of the chosen cephalometric landmarks. According to independent sample t-test, the two groups were not significantly different in identification of PNS (P=0.960), Ar (P=0.467) or Go (P=0.120). However, the mean error in identification of or was significantly lower in the smartphone group (P=0.020).

Discussion

This study compared the efficacy of smartphone learning versus lecture-based learning for cephalometric landmark identification by dental students. Dental students in the two groups were matched in terms of age, gender and grade point average, which was in agreement with the methodology of some previous studies [25, 26]. This was done to eliminate the confounding effect of these variables on the results. No significant difference was noted between the two groups in identification of PNS, Ar or Go (P > 0.05). However, the mean error rate in identification of or was significantly lower in the smartphone group (P = 0.020).

In a similar study in Basel University in Switzerland, the results showed that students in electronic learning group experienced 10% improvement in their level of knowledge compared with those in the traditional learning group [27]. This finding was in agreement with our results regarding knowledge enhancement in the smartphone learning group. Mitchell et al. [28] evaluated 231 nursing students and reported that students who had continuous access to educational content electronically gained higher scores. Basoglu and Akdemir [29] also confirmed the positive effect of using educational applications on the academic progression and learning of students, which was in agreement with our findings. Fernandez-Lao et al. [30] reported optimal efficacy of a smartphone application for enhancement of skills regarding ultrasound imaging. Leasure et al. [31] showed that electronic learning was 19% more effective than the traditional learning. Fozdar and Kumar [32] and Hartnell-Young and Heym [33] showed that educational smartphone applications had optimal efficacy for enhancement of learning.

Studies on the efficacy of electronic learning for instruction of cephalometric landmark identification are limited. Silveira et al, [24] in a randomized clinical trial in Brazil evaluated the learning process of lateral cephalometry by dental students using a learning virtual object and found that it was an efficient and effective tool for enhancement of the learning process and can greatly help in instruction of cephalometry. Their results were in agreement with our findings.

In contrast, some other studies have stated that adequate conditions are not available for replacement of traditional learning with electronic learning and these two methods of instruction should be preferably used in combination with each other [34]. For instance, Kavadella et al, [35] in Greece evaluated the efficacy of traditional instruction combined with electronic instruction compared with traditional instruction alone for oral and maxillofacial radiology topics and showed that the performance of the group that received combined instruction was significantly superior to the performance of the traditional learning group. Meckfessel et al, [36] at the School of Dentistry of Hanofer, Germany demonstrated the superior efficacy of the combined instcrution technique to the traditional instcrution alone. Sendra-Portero et al. [37] stated that electronic learning can be used as an alternative to traditional learning for instruction of radiology topics to dental students with no adverse effect on the learning process. However, they added that interaction and communication of students with their mentors and their attendance to classes are also an important part of the learning process. Thus, they suggested electronic instruction at first followed by holding several classes for in person problem solving. A recent study reported enhanced medical education and exam performance following tablet computer-based integrated training and clinical practice [38].

Most previous studies used electronic learning as an adjunct to traditional learning and showed its relative superiority compared with the traditional learning alone. However, in the present study, electronic learning alone was compared with traditional learning alone and the results revealed significant superiority of electronic learning in identification of one landmark. The efficacy of the two methods of learning was the same in identification of the other three landmarks. Thus, it may be concluded that smartphone learning can significantly enhance the process of learning since it is popular, easily accessible and effective. Smartphone learning has high potential for knowledge promotion and encouraging the students especially when used in combination with traditional learning. Future studies are recommended to design applications for instruction of other topics to dental students.

This study had some limitations such as small sample size. Future studies with larger sample size and in other universities are required to further assess the efficacy of electronic learning in instruction of complex topics.

Conclusion

Smartphone learning had a comparable, and even superior, efficacy to lecture-based learning for instruction of cephalometric landmark identification, and is recommended to enhance the instruction of complicated topics.

Declarations

Ethics approval and consent to participate

The study was approved in the ethics committee of Kermanshah University of Medical Sciences (IR.KUMS.REC.1397.791).

Consent for publication

All authors consent to publication of this manuscript.

Availability of data and material

All materials described in this manuscript including all relevant raw data, will be freely available to any scientist wishing to use them for non-commercial purposes, without breaching participant confidentiality.

Competing interests

The authors declare that they have no competing interests.

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Author Contributions:

AG devised the study concept, designed the study, acquisition of data, analysis and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, Administrative, technical, and material support and study supervision. FD contributed to the acquisition of data, analysis and interpretation of data, drafting of the manuscript, statistical analysis, administrative, technical, and material support collected data. MMI contributed to the study concept and design, acquisition of data, analysis and interpretation of data, drafting of the manuscript, statistical analysis, administrative, technical, and material support. NN contributed to the drafting of the manuscript, critical revision of the manuscript for important intellectual content, administrative, technical, and material support and study supervision. All authors read and approved the final manuscript.

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Tables

Table 1. Comparison of the two groups regarding errors in identification of the chosen cephalometric landmarks

Point	Group	Mean	Std. deviation	Minimum	Maximum	P value
PNS	Traditional learning	4.85	3.15	0	11	0.960
	Smartphone learning	4.89	2.95	0	10	
Ar	Traditional learning	21.65	6.75	2	39	0.467
	Smartphone learning	20.52	4.32	13	32	
Go	Traditional learning	6.92	3.72	2	19	0.120
	Smartphone learning	5.56	2.47	2	12	
Or	Traditional learning	6.65	6.24	2	27	0.020
	Smartphone learning	3.67	1.64	0	7	

Figures

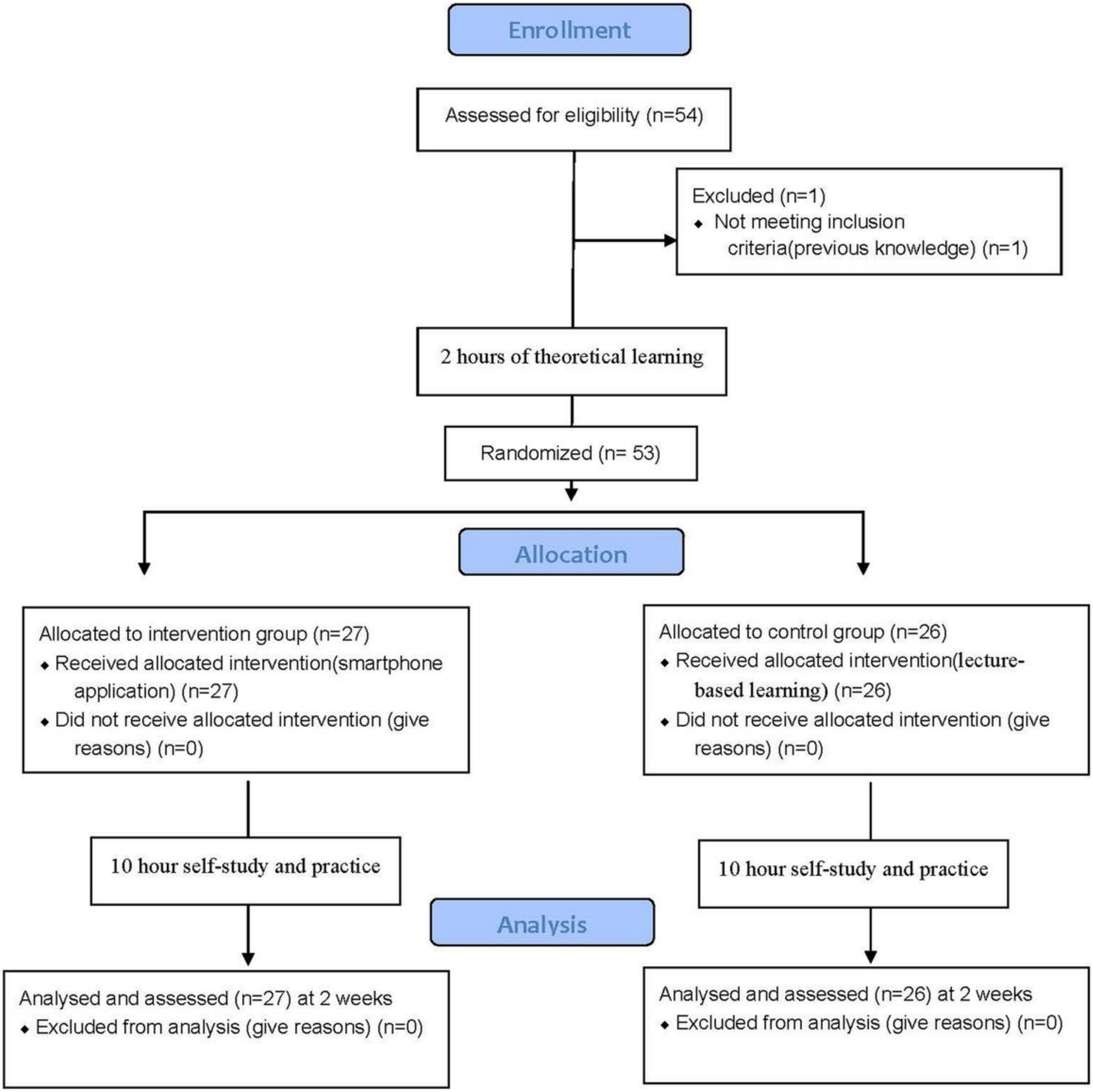

Figure 1

participants flow-chart

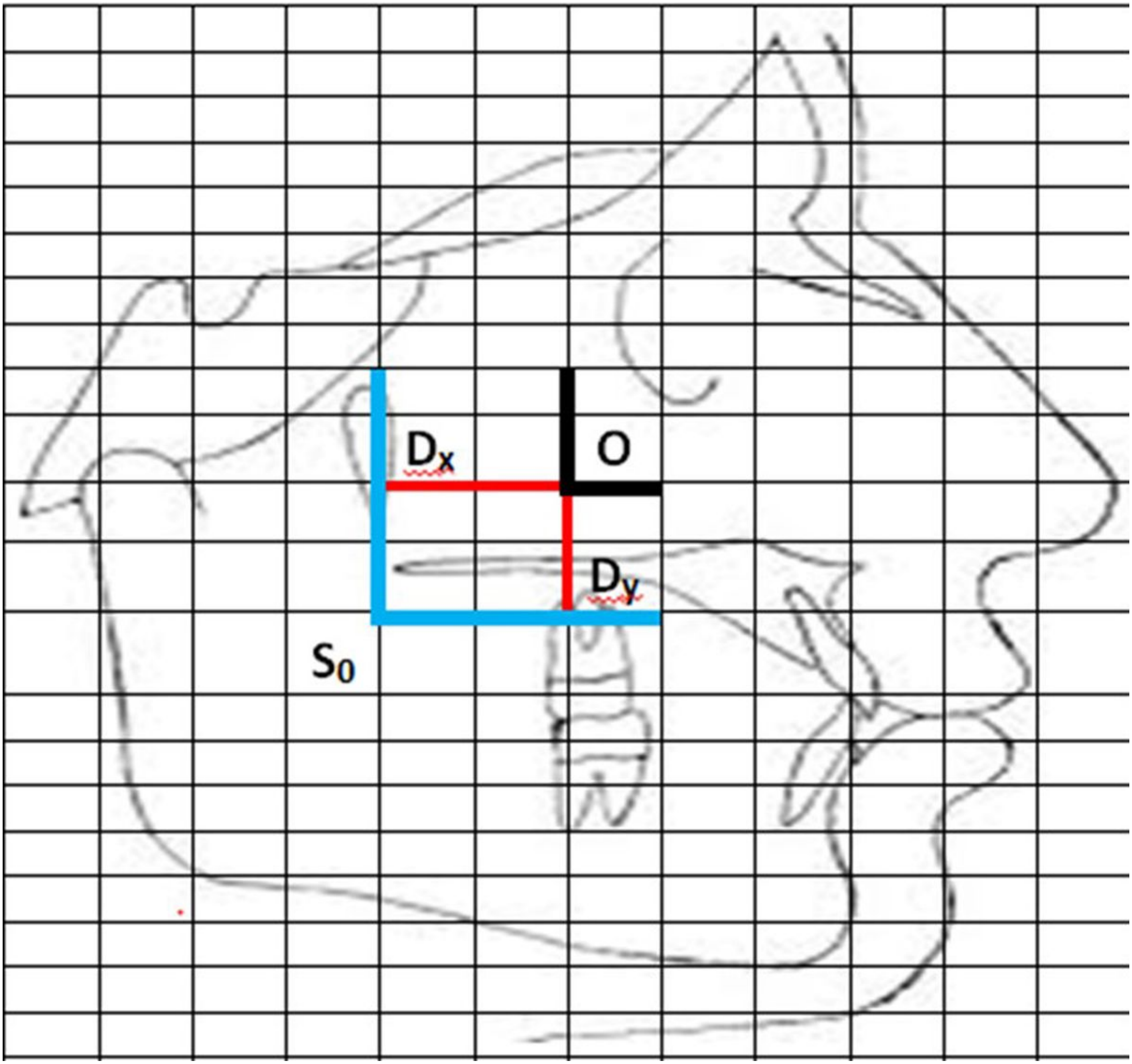

Figure 2

Schematic view of the comparison of landmarks identified by students with the reference points ($S0$=Reference point, O=Landmark identified by student, Dx: Distance between the two points in the X axis, Dy: Distance between the two points in Y axis, O-S0 distance: $D=\sqrt{(Dx^2+Dy^2)}$)