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A COMPARISON OF MANUAL TRACING, DIGITISING AND COMPUTER CEPHALOMETRIC ANALYSIS

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ABSTRACT

Thirty lateral cephalometric radiographs were assessed using each of three methods: manual tracing, using a digitising tablet and on-screen digitisation of the image of the cephalogram using a computer "mouse". There were significant differences between the three methods, with the on-screen digitising having advantages, in particular regarding the time taken to enter data, ability to enhance and enlarge portions of the image and ease of producing customised analyses.

INTRODUCTION

The value of accurate cephalometric analysis in orthodontics and orthognathic surgery is well established. Until twenty years ago, the method of choice for analysing cephalometric radiographs was manual tracing. Richardson (1981) compared manual tracing with a direct method using a digitising tablet. He found that direct digitisation gave smaller standard deviations and therefore was more reproducible. Jackson et al. (1985) studied the reproducibility of "on screen" computer digitisation. in which the cephalograms were imaged onto the computer screen via a video camera,
with conventional manual tracing. They found that the on-screen digitising method was comparable with the manual tracing method. Oliver (1991) found that conventional digitising, on-screen digitising and manual tracing were all comparable in accuracy.
Although the time-honoured process of hand tracing and analysing cephalometric radiographs is still clinically useful, it has clear drawbacks. One major disadvantage is the amount of time required for hand tracing and performing the various analyses.
The aim of this study was therefore to assess the relative merits of manual tracing, digitising and the more recently introduced computer generated cephalometric analysis (using OTP by Ortho Vision). It was hoped that the study would address the question of reproducibility of the above methods, and to show differences in intra and inter-examiner reproducibility.

METHOD

30 lateral cephalometric radiographs, picked at random, were assessed using each of the three methods by the two examiners, both in their second year of postgraduate orthodontic training. Intra and inter-examiner reproducibility were checked by re-analysing all 30 radiographs after one month.

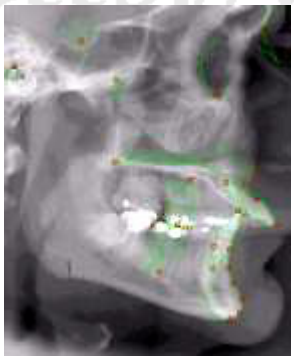

Fig. 1

For manual tracing a hard HB 0.5mm lead pencil was used on good quality acetate sheets fixed to the radiographs with clear adhesive tape.

A well-illuminated light box was used in a darkened room. The analysis was then performed by hand with the use of a protractor and ruler.

The second method involved the use of a digitising tablet which is a peripheral computer device that has two parts, the tablet and the "cross-hair" cursor. Direct digitisation of each cephalogram was then accomplished by placing it on the digitising tablet, which consists of a plate glass impregnated with an electronic grid on a light box, and using the cursor to enter the anatomical points by activating the button on the cursor. The electronic signal from the cursor is received by the digitising tablet, which registers the data in an x and y coordinate system that is then stored in the computer.

In the third method of on-screen digitisation the image of the cephalogram is fed directly into the computer by a connected video source and therefore "fixed" on the monitor screen. The image is then indirectly digitised using the "mouse" (figure 1).

Fig.2

STATISTICAL ANALYSIS

Dahlberg's error of the method (as suggested by Houston, 1983) was used to look at intra and inter-examiner reproducibility. Table I shows the results
from the first examiner, and Table II from the second examiner.

Intraclass correlation coefficient (as suggested by Fleiss) was used to compare the three methods of measuring data when used by the two examiners
(Table III).

Table I

	MANUAL	TABLET	ON-SCREEN
SNA	1.29	0.62	0.40
SNB	0.92	0.52	0.39
ANB	0.72	0.76	0.37
MMPA	1.44	0.52	0.88
U1-MxP	1.63	0.91	0.99
L1-MnP	3.02	0.73	0.66
UAFH	1.07	0.67	0.49

LAFH	0.86	0.79	0.41

Table II

	MANUAL	TABLET	ON-SCREEN
SNA	0.66	0.40	1.06
SNB	0.60	0.43	1.47
ANB	0.72	0.50	0.84
MMPA	1.58	0.46	1.43
U1-MxP	0.84	0.70	1.90
L1-MnP	0.95	0.57	1.23
UAFH	0.92	1.44	2.01
LAFH	0.81	0.65	2.76

Table III

METHOD	INTRA-CLASS CORRELATION COEFFICIENT (after Fleiss)
MANUAL TRACING	0.997
DIGITISING with tablet	0.987
ON-SCREEN DIGITISING	0.996

RESULTS

The principles of cephalometric analysis are not different when computers are used, however, there were significant differences between the three methods. Intra-examiner reproducibility for the first examiner showed digitising on tablet to be the most accurate and manual tracing the least accurate method (Tables I). For the second examiner digitising on tablet was still the most accurate, but on-screen digitising was the least accurate method (Table II). Inter-examiner reproducibility showed digitising on tablet to be the most accurate and manual tracing the least accurate method.

There was very little difference in the three methods of measurement between the two examiners (Table III).

DISCUSSION

The most reproducible method for the first examiner was on-screen digitisation, but this was not the case for the second examiner. This may have been due to the first examiner making better

use of the ability to enhance images by altering contrast and sharpness, and the ability to magnify portions of the image to aid in landmark identification (figures 1 and 2).
The ease of producing and using customised analyses was a very useful benefit of the on-screen digitisation, and this significantly reduced the time taken to analyse the data.

CONCLUSIONS

It is evident that the use of computer software packages has changed cephalometric analysis in orthodontics. Recent technological advances have allowed the use of image capturing systems and manipulation of the image. With on-going reduction in prices, computerised cephalometric technology is now well within the reach of most practising orthodontists. However, it is still anticipated that manual tracing will remain popular, as it is still less costly and more easily accessible.

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