Validity of digital cephalometric tracing: A systematic review

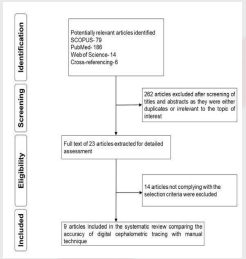
Alia Chaudhry, Frank W. Licari, Shankargouda Patil

Objective

The aim of this systematic review was to assess the accuracy of digital cephalometric tracing with manual hand tracing.

Materials and Methods

Electronic records of PubMed, SCOPUS and Web of Science databases were searched. Initial search revealed 279 potentially relevant articles. Relevant articles were selected after examining titles and abstracts. After screening, 23 full text articles were assessed in detail. 15 publications were excluded for not meeting the predetermined inclusion criteria. The methodological quality of the selected 9 studies was assessed using 12 criteria related to study design, measurement and statistical analysis used.



Results

Table 1: Summary of data extracted from the included studies

S. No	Author/Year /Country	Sample size	Observers	Repetition	No. of landmarks	No. of variables	Software used	Statistical analysis used	Results	Inference
1	Dvortsin. 2008 Netherlands	20	1	1	15	15	Viewbox v3.1.1.0	ANOVA	Statistically significant differences seen in 11 variables. Except for 1 point, mean all differences were less than 1mm.	Two methods have statistically significant differences. Clinical relevance of differences is questionable.
2	Celik, 2009 Turkey	125	1	1	26	28	Vistadent 2.1	ICC, ANOVA, Duncan's test	Differences seen in linear measurement parameters. 7 variables including nasolabial angle showed low reproducibility.	Few measurements in Vistadent showed low correlation with hand tracing. Differences were minimal & clinically acceptable.
3	Polat-Ozsoy 2009, Turkey	30	1	1	26	26	Vistadent 1.1	ICC, paired t test	Statistically significant differences seen in 10 points.	Discrepancies seen between digital and hand tracing. Differences clinically acceptable.
4	Tsorovas 2010 Sweden	30	1	2	27	23	FACAD, OrthoCeph, OrthoCeph, Viewbox, Winceph	ICC, student t- test, Kolmogorov-Smirnov	All points showed good reproducibility except AB on FOF and A-Pog.	Cephalometric measurements made on all software were in good agreement with hand tracing
5	Tikku 2013 India	40	1	1	22	26	Nemoceph h v6.0	ICC, paired t test	16 linear and angular measurements showed statistically significant differences between digital and hand tracing.	Except SN-Occlusal plane angle, all differences seen are clinically insignificant. Double images of occlusal surfaces of teeth may have interfered with identification of occlusal plane
6	Prabhakar 2014 India	30	1	Unclear	Unclear	21	Nemoceph hiDolphin	ANOVA, Tukey, Kruskal Wallis	Two variables showed statistically significant differences between digital and hand tracing p<0.05	Differences seen in hand and digital tracing. Differences are clinically acceptable.
7	Goracci 2014 Italy	20	1	1	17	11	Nemoceph h NX 2009, Smileceph	ICC, t-test	Differences in measurements were not statistically significant.	All measurements indicate a high agreement between tracing methods
8	Farooq 2016 India	50	1	Unclear	27	30	FACAD v5.6	ICC, t test	7 variables showed statistically significant differences between digital and hand tracing	Measurements performed using digital and hand tracing showed good reproducibility and reliability.
9	Pekiner 2019 Turkey	150	1	1	18	18	OrtoxCap h v3.1.54	Shapiro-Wilks, paired t test	9 variables showed statistically significant differences. 7 were	Differences seen are believed to be clinically insignificant.

Results revealed statistically significant differences between the methods for certain variables. Cephalogram quality, lip posture, positioning, difficulty in locating landmarks had an influence on variations in measurement. However, these differences were minimal and clinically acceptable.

Conclusion

Moderate quality evidence was found that showed digital cephalometric tracing to be equally reliable to manual tracing. The systems described are accurate enough in the hands of a competent clinician. Their errors are no greater than those seen with manual tracing.

Table 2: Methodologic quality scores of the included articles

S. No.	Author	Year	A	B	C	D	E	F	G	H	I	J	K	L	Total	Quality
1	Dvortsin	2008	0	0	1	1	2	2	1	1	1	1	2	1	13	Moderate
2	Celik	2009	0	1	0	1	2	2	1	1	1	2	2	1	14	Moderate
3	Polat-Ozsoy	2009	0	0	0	1	2	2	0	1	1	2	2	1	12	Moderate
4	Tsorovas	2010	0	1	0	1	2	2	1	1	1	2	2	1	14	Moderate
5	Tikku	2013	0	1	1	1	2	2	0	1	1	2	2	1	14	Moderate
6	Prabhakar	2014	0	0	0	1	0	2	1	0	0	2	1	1	8	Low
7	Goracci	2014	0	1	0	1	2	2	0	1	0	2	2	1	12	Moderate
8	Farooq	2016	0	1	0	1	0	2	0	0	0	1	2	1	8	Low
9	Pekiner	2019	0	1	1	1	2	2	1	0	0	2	2	1	13	Moderate

Clinical Implications

Digital cephalometric analyses can potentially improve the workflow in a clinic and research settings saving time and effort.

References

1. Tsorovas G, Linder-Aronson Karsten A. A comparison of hand-tracing and cephalometric analysis computer programs with and without advanced features - Accuracy and time demands. Eur J Orthod. 2010;32(6):721–8.
2. Celik E, Polat-Ozsoy O, Toygar Memikoglu TU. Comparison of cephalometric measurements with digital versus conventional cephalometric analysis. Eur J Orthod. 2009;31(3):241–6.
3. Polat-Ozsoy O, Gokcelik A, Toygar Memikoglu TU. Differences in cephalometric measurements: A comparison of digital versus hand-tracing methods. Eur J Orthod. 2009;31(3):254–9.

ROSEMAN UNIVERSITY OF HEALTH SCIENCES
TRANSFORMING EDUCATION · REIMAGINING HEALTHCARE · EMBRACING DISCOVERY · COMMITTED TO COMMUNITY