

# Validity of digital cephalometric tracing: A systematic review

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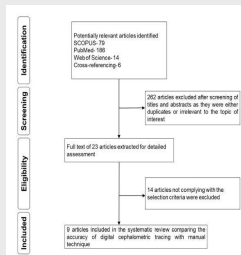
## Objective

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	Drosten, 2008 Netherlands	20	1	1	15	15	Viewbox 5.1.1.19	ANOVA	Statistically significant differences seen in 12 variables. Except for 1 point, none of the differences were statistically significant.	Two methods have statistically significant differences. Clinical differences in measurements were not statistically significant.
2	Celik, 2009 Turkey	125	1	1	26	26	Viewbox 2.1	ICC, ANOVA, Duncan's test	Statistically significant differences seen in 16 variables. Except for 1 point, none of the differences were statistically significant.	Few measurements in Viewbox showed less correlation with hand tracing. Differences were minimal & clinically acceptable.
3	Polat-Ozsoy, 2009 Turkey	30	1	1	26	26	Viewbox 2.1	ICC, paired t-test	Statistically significant differences seen in 10 points.	Discrepancies seen between digital and hand tracing. Differences clinically acceptable.
4	Isidorsson, 2010 Sweden	30	1	2	27	23	TACAD, OpenCeph, QMCeph, Viewbox, Mimash	ICC, student t-test, Kolmogorov-Smirnov	All points showed good reproducibility except AB on POP and A-EG.	Cephalometric measurements made on all software were in good agreement with hand tracing.
5	Tikka, 2013 India	40	1	1	22	26	Nempep h.v.e.p	ICC, paired t-test	14 linear and angular measurements showed statistically significant differences between digital and hand tracing.	Except SN-Orbital plane angle, all differences were statistically insignificant. Greater degree of vertical distance of teeth may have interfered with identification of occlusal plane.
6	Prabhakar, 2014 India	30	1	Unclear	Unclear	21	Nempep hDelphin	ANOVA, Turkey, 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	Genesi, 2014 Italy	30	1	1	17	11	Nempep h, N2, Simulograph	ICC, t-test	Differences in measurements in hand and digital tracing. Differences are statistically significant.	All measurements indicate a high agreement between tracing methods.
8	Farooq, 2016 India	50	1	Unclear	27	30	EACAD v.6	ICC, t-test	Statistically significant differences between digital and hand tracing. 9 variables showed statistically significant differences. 2 were	Measurements performed using digital and hand tracing showed good reproducibility and reliability.
9	Eskilser, 2019 Turkey	150	1	1	18	18	Shaping-Works, OpenCap h.v.3.1.154	Shapiro-Wilk's, paired t-test	Statistically significant differences seen in 18 variables.	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	Drosten	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	Isidorsson	2010	0	1	0	1	2	2	1	1	1	2	2	1	14	Moderate
5	Tikka	2013	0	1	1	1	2	2	0	0	1	2	2	1	14	Moderate
6	Prabhakar	2014	0	0	0	1	0	2	1	0	2	2	1	1	8	Low
7	Genesi	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	Eskilser	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

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- 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.
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