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Homology and heterology of cephalometric landmarks: methodological consequences

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Sir,

With interest I read the study 'Effects of maxillary protraction for early correction of class III malocclusion' by Celikoglu and Oktay (1). The authors should be complimented for careful work. Apparently, much effort was taken to avoid traditional pitfalls in the (prospective) collection of study subjects and controls, in reporting measurement technique and in statistical procedures.

But why then do conclusions from this study raise doubts?

My criticism is focussed on a fundamental issue in cephalometric methodology. The authors implicitly assume that skeletal landmarks introduced into the radiographic images, when used in longitudinal or serial material in growing individuals are homologous. However, these landmarks are not homologous, but heterologous in the way they are used in the present evaluation. That condition seriously limits the potential for clinically relevant conclusions (2). The reason for the heterology of the landmarks is the dual process of skeletal articular or sutural growth displacement and periosteal remodelling simultaneously taking place during the time interval. The spatial position of all the landmarks used in the present study is directly or indirectly subject to variable displacement and variable periosteal remodelling influences. When skeletal growth remodelling is *not* taken into account, like in the present study, conclusions must be limited to generalized interpretation of group size/shape changes.

The effect is that an explanation of differences and variation is largely impossible. In particular, this holds for the conclusions based on tooth position changes relative to the jaws and the relative contribution of 'skeletal' or 'dentoalveolar' changes (Figure 5, and conclusions 2 and 3).

It is my opinion that the current search for evidence-based treatment methods includes that investigators should select a valid biologically evidence-based method of evaluation. The method available is the structural method of superimposition, based on the principles of bone growth remodelling and a range of implant-marker studies revealing natural reference markers [(3), see (4) for a review]. After structural superimposition landmarks are homologous. The application of structural superimposition in the present study would provide advanced insight in variation and result in clinically more relevant conclusions.

References

1. Celikoglu, M. and Oktay, H. (2014) Effects of maxillary protraction for early correction of class III malocclusion. *European Journal of Orthodontics*, 36, 86–92.
2. Duterloo, H.S. (2014) A reflection on radiographic cephalometry: the evaluation of sagittal discrepancy. *Journal of Orthodontics*. First published on February 12, 2014, 10.1179/1465313313Y.0000000085
3. Björk, A. and Skieller V. (1983) Normal and abnormal growth of the mandible: A synthesis of longitudinal cephalometric implant studies over a period of 25 years. *European Journal of Orthodontics*, 5, 1–46.
4. Duterloo, H.S. and Planché, P-G. (2011) *Handbook of cephalometric superimposition*. Quintessence Publishing, Hanover Park, IL.

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Reply

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Sir,

We would like to express our thanks to Dr Duterloo for his interest in our study (1) entitled 'Effects of maxillary protraction for early correction of class III malocclusion' and his appreciation of our efforts.

Information obtained from previous implant studies as well as animal and human autopsy material has shown that there are highly stable regions in the cranial base. The superimposition of cephalometric lateral films on relatively stable anatomic structures is

considered the most reliable and precise method for facial superimpositions (2). However, we would like to point out that the structural superimpositions show the treatment changes obtained by applied mechanics visually in individual basis. In contrast, in the present study, we aimed to evaluate the treatment outcomes quantitatively by measuring the particular angles and distances using the pterygomaxillare (PM) vertical (PMV) as a reference line. The landmarks of wings and PM on the middle cranial base were used to create the PMV since the middle cranial base completes its development due to the protection of the brain and other vital organs and thus its stability after 8 years of age makes it an excellent baseline for the facial growth studies (3, 4). In a recently published study (5), the landmarks of wings and PM were found to be remained stable in both horizontal and vertical directions between the ages of 12 and 15 years. As an alternative to the PMV line used in our study, the tuberculum sella-wing (T-W) reference line was stated to be a reliable method for examining the facial changes since it was found to be the most similar superimposition method to Bjork's structural method (5).

We agree with Dr Duterloo regarding the conclusions since the findings that were found in the study are the combinations of skeletal and dentoalveolar changes induced by the protraction appliance we used and the patients' growth processes. To eliminate it, we used a well matched untreated control group with Class I malocclusion. As previously stated in our study, ethical considerations did not allow postponing the treatment of Class III subjects for scientific purposes and thus the control group was formed by the subjects with dental and skeletal Class I relationship.

We would like to thank once again Dr Duterloo, as discussion on these issues helps to clarify matters.

References

1. Celikoglu, M. and Oktay, H. (2014) Effects of maxillary protraction for early correction of class III malocclusion. *European Journal of Orthodontics*, 36, 86–92.
2. Björk, A. (1968) The use of metallic implants in the study of facial growth in children: method and application. *American Journal of Physical Anthropology*, 29, 243–254.
3. Moss, M.L. and Greenberg, S.N. (1955) Postnatal growth of the human skull base. *Angle Orthodontist*, 25, 77–84.
4. Hilloowala, R.A., Trent, R.B. and Pifer, R.G. (1998) Interrelationships of brain, cranial base and mandible. *Cranio*, 16, 267–274.
5. Arat, Z.M., Türkkahraman, H., English, J.D., Gallerano, R.L. and Boley, J.C. (2010) Longitudinal growth changes of the cranial base from puberty to adulthood. A comparison of different superimposition methods. *The Angle Orthodontist*, 80, 537–544.