

Cranio-facial Reconstruction of St Laszlo the Hungarian King from the 11th century

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Short title: Craniofacial reconstruction of king St Laszlo

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King László I. (1046–1095) of Hungary was very famous throughout Europe in the Middle Ages. After his canonization (in 1192) his tomb was opened and his head was placed into a reliquary (herm). The original herm was destroyed by a conflagration, yet the skull remained preserved. The present herm was made during the XVth century and has been kept in the Our-Lady-Cathedral in Győr to date. Although the Holy King was immortalized by several preserved frescos in medieval Hungarian churches, we lack any authentic portrait from during his lifetime.

The first aim of our study was to prove the originality of the skull relic assigned to King László I. by physical anthropological methods. The second aim was to revive the authentic feature of the king's face using craniofacial reconstruction, while estimating the missing mandible needed for this reconstruction. The final aim was to evaluate the similarity of the resulting reconstruction to the herm.

In order to estimate the missing mandible, a reference database of 3D CT images of Western-Caucasian (N=102) complete and contemporaneous Hungarian (N=12) nearly complete skulls was used. These images were first segmented into skeletal tissue, landmarked using a fully automatic spatially-dense landmarking procedure and geometrically superimposed using Procrustes alignment, resulting in an average skull shape and linear modes of statistical shape (co-)variation. Estimation of the missing mandible was obtained by fitting this complete statistical model to the partial skull. The fitting changes the average skull shape to the given partial skull shape, whilst simultaneously detecting and estimating missing parts using the co-variation present in the model. This procedure was validated using leave-one-out cross-

validation on the two ancestral subsets, separately and combined. A traditional sculpting method for craniofacial reconstruction was applied to a 3D copy of the skull. Finally, similarity to the herm was tested using 3D surface registration methods.

The anthropological investigation confirmed the originality of the skull-relic. The first attempt of the mandible reconstruction, based on the strictly western-caucasian ancestry database, resulted in a high and long mandible shape with a prominent chin. Inclusion of a small number of contemporaneous skulls resulted in a shorter mandible with slightly retrognathic chin. The craniofacial reconstruction was fairly different from the herm. This can be partly explained by the fact that the present herm was made 400 years after the king's death, so the goldsmith master could not have had any thorough knowledge of the King's face.