Title

Statistical analysis of interactive surgical planning using shape descriptors for fibular transfer in mandibular reconstruction

Megumi Nakao[1], Shimpei Aso[1], Keiho Imanishi[2], Yuichiro Imai[3], Nobuhiro Ueda[4], Toshihide Hatanaka[4], Mao Shiba[4], Tadaaki Kirita[4] and Tetsuya Matsuda[1]

[1] *Graduate School of Informatics, Kyoto University, Kyoto, Japan*

[2] *E-growth co. ltd, Kyoto, Japan*

[3] *Department of Oral and Maxillofacial Surgery, Rakuwakai Otowa Hospital, Kyoto, Japan*

[4] *Department of Oral and Maxillofacial Surgery, Nara Medical University, Nara, Japan*

Keywords: fibular transfer planning, shape analysis, quantitative evaluation, mandibular reconstructive surgery

Purpose

This study presents an improved design of preoperative planning with generalized quantitative shape indicators for fibular transfer in mandibular reconstruction. A user experiment was performed to quantitatively analyze reconstruction plans and decision-making in preoperative planning.

Methods

Three shape descriptors were designed to evaluate local differences between reconstructed mandibles and patients' original mandibles. We targeted an asymmetrical, wide range of cutting areas including the mandibular sidepiece, and defined a unique three-dimensional coordinate system for each mandibular image. The generalized algorithms for computing the shape descriptors were integrated into interactive planning software [1][2], where the user can refine the preoperative plan using the spatial map of the local shape distance as a visual guide. (see **Fig. 1**)

Results

A retrospective study was conducted with two oral surgeons and two dental technicians using the developed software. The obtained 120 reconstruction plans show that the participants preferred a

moderate shape distance rather than optimization to the smallest. We observed that a visually plausible shape could be obtained when considering specific anatomical features (e.g., mental foramen. mandibular midline).

Conclusion

This work introduces the shape distance for quantification of local differences between planned mandibular reconstruction and the patient's native mandible. The preoperative plan can be refined using the three-dimensional map of the shape distance. Use of the map for visual guidance will assist fine adjustment of the fibular segments. The proposed descriptors can also be used to multilaterally evaluate reconstruction plans and systematically learn surgical procedures.

Figure

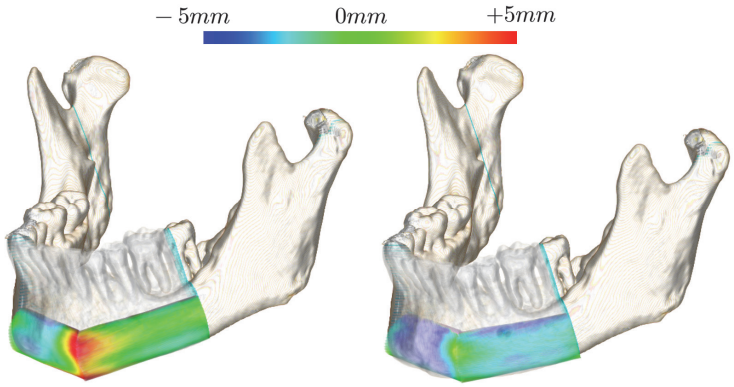

Fig. 1. Shape distance computation and mapping on the oriented fibular segments: (a) the red color shows that the fibular implants near the connection point protrudes from the patient's native mandible, and (b) the blue color indicates depression from the patient's native mandible.

Reference

[1] Nakao M, Hosokawa M, Imai Y, Ueda N, Hatanaka T, Kirita T, Matsuda T (2015) Volumetric fibular transfer planning with shape-based indicators in mandibular reconstruction. IEEE Journal of Biomed Health Informatics, 19 (2): 581-589.

[2] Aso S, Nakao M, Imanishi K, Imai Y, Ueda N, Hatanaka T, Kirita T and Matsuda T, (2015) A study on semi-automatic fibular transfer planning in mandibular reconstruction, Proc. Medical and Biological Imaging: 6.