Bildanalyse für die Planung von Halslymphknotenausräumungen
Image Analysis for Neck Dissection Planning

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Purpose

To enhance preoperative planning and decision making in neck dissection surgery with interactive 3d visualizations of relevant structures.

Material and Methods

13 datasets (9 CT, slice distance of 1-3 mm and 4 MR datasets, slice distance 2-4 mm) were acquired for preoperative planning. Segmentation target structures are vascular structures, nerves, lymphnodes, muscles and bones in the neck region as well as the gl. parotis and the gl. submandibularis.

Image analysis was carried out with MeVisLab (MeVis, Bremen) where a variety of image preprocessing and segmentation methods is available. Among those, live wire segmentation was employed for the segmentation of the muscles (M. sternocleidomastoideus, M. digastricus), the gl. parotis, and the gl. submandibularis. With this semi-automatic approach the user selects some seedpoints and the system calculates a path of minimal cost in-between. This procedure is carried out in selected slices; the intermediate contours are interpolated (Schenk, 2000). The interactive watershed transform (Hahn, 2003) was suitable to identify the v. jugularis. Intensity based region growing was used for bone segmentation.

Facilities to compute the extent of anatomic structures and the distance between structures are also provided. With these facilities, the extent of enlarged lymph nodes can be determined precisely. The measurements are directly included in the 3d visualization. Enlarged lymph nodes were found in 3 datasets.

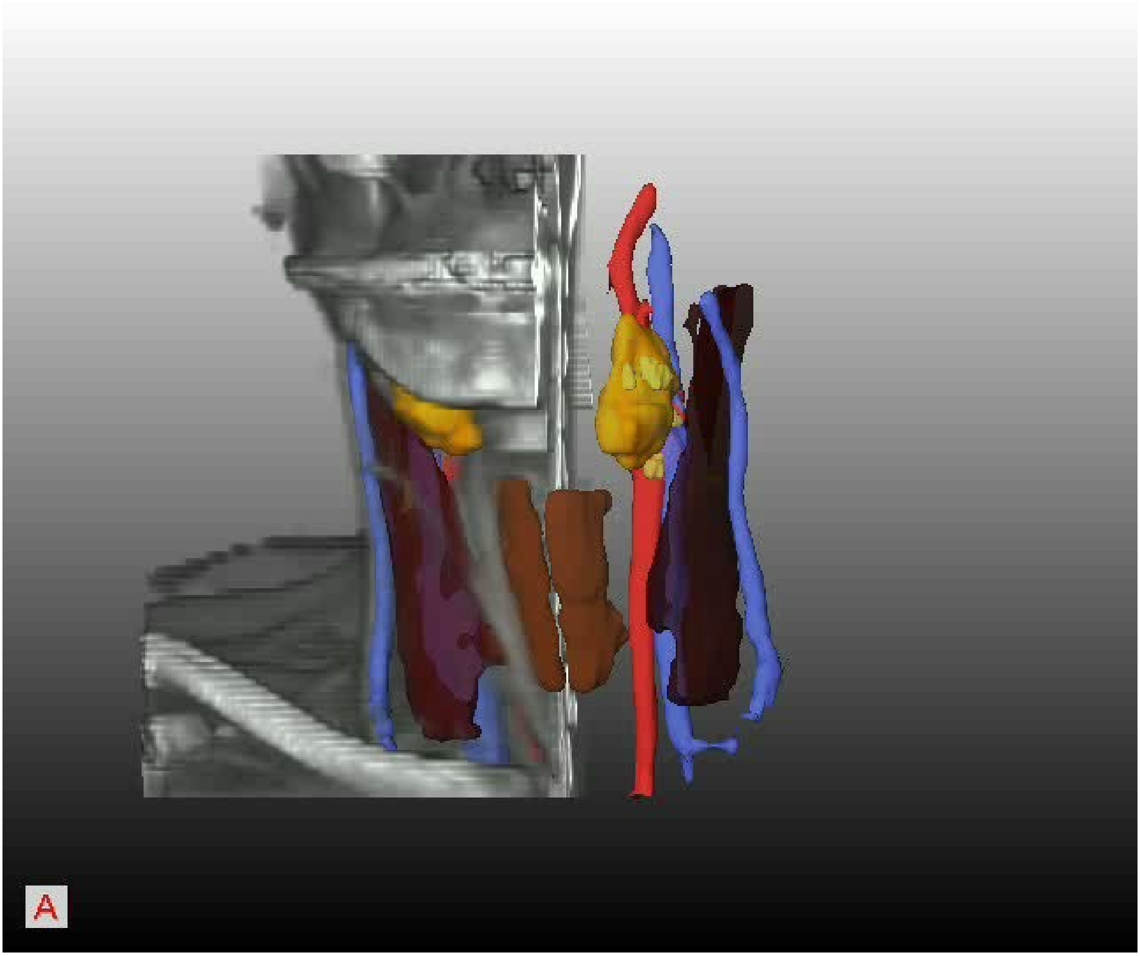
2d-slice views with the segmentation results transparently overlaid to the original data were created to support the verification of segmentation results and the mental integration of 3d visualizations with the underlying slice data (Fig. 1). Selective clipping of bony structures is used to enhance the interpretation of the spatial relations (Fig. 2).

Results

Standardized visualizations and movies were created for the clinical partner. The use of colours, transparency values and transfer functions for volume rendering was carefully discussed and standardized to provide reproducible visualizations (Fig. 3). To ensure the optimal availability of the results, the images and video sequences are presented on a password-protected structured website. While the muscles and the glands could be identified in most of the datasets, all desired nerves could not be identified due to their size in relation to the image resolution.
Among the vascular structures, only the largest, the A. carotis and V. jugularis, could be segmented in most of the data. The average time for image analysis and creation of visualizations was about 2 hours which is too much for regular clinical use. Most of the time was spent on the segmentation of long structures occurring in many slices with live wire. Statistical analysis concerning grey values, gradients and shapes reveal potential for model-based segmentation for some of the target structures.

Conclusion

Image analysis and interactive 3d visualization improve the understanding of the complex spatial relations in the neck area. However, high resolution radiologic data are required to depict small but relevant structures. The quantitative analysis of lymph nodes directly supports tumor staging. The structured web-based reports support efficient therapy planning and may be used as the basis for an educational system.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