Int. J. Oral Maxillofac. Surg. 2014; 43: 156–162
http://dx.doi.org/10.1016/j.ijom.2013.09.005, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Research Paper
Head and Neck Oncology

Optimization of the interface between radiology, surgery, radiotherapy, and pathology in head and neck tumor surgery: a navigation-assisted multidisciplinary network

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Abstract. A navigation-assisted multidisciplinary network to improve the interface between radiology, surgery, radiotherapy, and pathology in the field of head and neck cancer is described. All implicated fields are integrated by a common server platform and have remote data access in a ready-to-use format. The margins of resection and exact locations of biopsies are mapped intraoperatively. The pathologist uses the numerical coordinates of these samples to precisely trace each specimen in the anatomical field. Subsequently, map-guided radiotherapy is planned. In addition to the benefits of image-guided resection, this model enables radiotherapy planning according to the specific coordinates of the resection defect plus any residually affected sites identified by the pathologist. Irradiation of adjacent healthy structures is thereby minimized. In summary, the navigation-assisted network described grants timely multidisciplinary feedback between all fields involved, attains meticulous pathological definition, and permits optimized coordinate-directed radiotherapy.

Key words: navigation; computer-assisted surgery; image-guided surgery; head and neck cancer; computer communication network.

Accepted for publication 3 September 2013
Available online 5 October 2013

The treatment of malignant tumors of the midface, paranasal sinuses, and skull base requires an interdisciplinary approach combining surgery, radiotherapy, and oncology in order to obtain an optimal balance between tumor control and quality of life.

For obvious reasons, tumor margins are always narrow in the region of the head and neck. In addition, extended involvement, the need to preserve important neighboring structures, or a difficult dissection due to a distorted normal anatomy

0901-5027/020156+07 $36.00/0

after recurrence, may leave the radiotherapist a delicate task. Indeed, detailed information – especially that related to critical areas – is crucial for optimal treatment planning by the radio-oncologist.

Traditional models of data exchange between the various disciplines involved in head and neck tumor management are often inaccurate and incomplete. As a result, there is a risk of uncoordinated approaches to treatment.[1] The basic document for subsequent co-adjuvant planning by the radiotherapist is the operative report describing the intraoperative findings and the outcome of the resection. The locations of intraoperative biopsies are described by the surgeon in anatomical terms as best as possible, but tend to be inaccurate and based on non-standardized reference landmarks. These difficulties may lead to the need to direct radiotherapy at the entire initial tumor volume, rather than focusing on critical coordinate-defined regions resulting from comprehensive pathological analysis.

Fortunately, various refinements in the fields of radiotherapy and surgery have been implemented in order to improve the treatment of head and neck tumors. On the one hand, technical developments allowing for high-dose irradiation of small tissue volumes have allowed for the significant reduction of collateral damage in healthy neighboring areas. On the other, the incorporation of intraoperative imaging devices and surgical navigation systems into the clinical routine has provided the surgeon with a real-time guidance system based on a preoperatively simulated treatment plan.[1–11] The rapidly developing technologies for three-dimensional (3D) visualization, interactive localization, and point mapping enable precise identification and documentation of critical areas and intraoperative biopsies.[1] As a result, the quality of the intraoperatively obtained data is improved substantially. However, in most settings, the transfer of information is still via written reports and single screenshots of image datasets or intraoperatively-acquired points.

The aim of this preliminary report is to describe the navigation-assisted multidisciplinary network solution for head and neck cancer that has been implemented at our center. Based on the central aim to improve the interface between radiology, surgery, radiotherapy, and pathology, this network model stores all the relevant information necessary for each of the involved medical fields in a central server and allows for interactive, multidirectional data flow between all implicated participants.

Description of a navigation-assisted multidisciplinary network for head and neck cancer

The network consists of the components listed below (Fig. 1).

Servers

The heart of the network consists of a PACS (Picture Archiving and Communication System) and an iPlan® Net server (Brainlab AG, Germany). From any particular interrelated workstation, every participant in the network has full access to both servers in order to extract and introduce information.

Diagnostic radiology

Image acquisition is performed with a computed tomography (CT) and/or magnetic resonance imaging (MRI) device, depending on the optimal visualization method for the precise pathology and anatomical location. These primary DICOM (Digital Imaging and Communications in Medicine) datasets are stored in the PACS.

Preoperative planning and navigation

In our unit, the Brainlab Vector Vision® (Brainlab AG, Germany) navigation

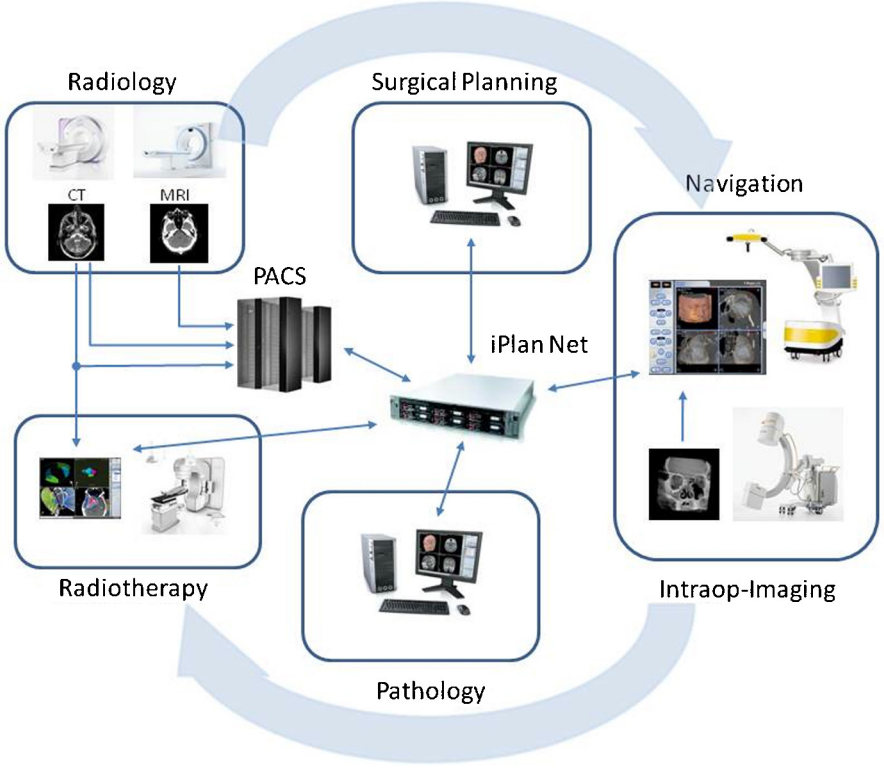

Fig. 1. Network scheme: Integration of all involved workstations under a common PACS and iPlan® Net server.