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Image guided surgery: New technology for surgery of soft tissue and bone sarcomas

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Abstract

Aim: Providing the surgical oncologist with a new means of performing safe and radical sarcoma surgery with the help of image guidance technology.
Method: Two patients with pelvic sarcomas were operated upon with the help of an intra-operative navigation system. The technology of image guided surgery is described in one patient with a retroperitoneal sarcoma invading the bony pelvis and another patient with a chondrosarcoma of the iliac crest.
Results: We show that this new procedure enables optimal radical surgical resection with minimal treatment related morbidity or loss of function.
Conclusion: Image guided surgery is a new technical tool in sarcoma surgery.

Keywords: Image guided surgery; Soft tissue sarcoma; Bone sarcoma; Navigation system; Computer aided surgery

Introduction

The incidence of soft tissue and bone sarcomas in the Netherlands is 800 patients a year and therefore they represent only a small portion of new patients seen by surgical oncologists.[1] The wide range of histological diversity, diagnostic work up, (neo-) adjuvant therapy and surgical options require that these malignancies are generally treated in so-called 'sarcoma centres'. Resection of these malignancies in the pelvic area is technically demanding and due to local anatomy it is difficult to get a tumour free resection margin. This means that the tumour sites have a high tendency for local recurrence, and the surgery in itself can be very incapacitating for a patient especially when the sarcoma invades adjacent structures.

Generally sarcoma surgery is performed by experienced surgeons, who rely mainly on their clinical judgement in combination with a radio diagnostic work up with spiral CT and/or MRI.

These recently developed three-dimensional computed tomographic reconstructions of the human body have added an improved perspective to a data set usually presented in axial and coronal slices, but are still not always sufficient for intra-operative surgical guidance.

Image guided surgery (IGS) applies computer-based image processing of two- and three-dimensional radiological information to intra-operative visualization and guidance. This enables the clinician to better understand the relationship between malignant tumours and their surrounding structures. A more safe and tailored surgery, possibly combined with pre-operative chemo- and/or radiotherapy, can be performed with pre- and intra-operative treatment planning. The ultimate goal of surgery should always be radical tumour resection, and with proper registration, accuracy within

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2 mm can be obtained. Cross-sectional imaging based on navigation and virtual reality planning tools were recently introduced in orthopaedic- and neurosurgery for spinal procedures. The technique of image guided surgery might be applicable in sarcoma surgery of soft tissue tumours invading bony structures or bone sarcomas. It remains unclear whether 3D planning and tools really increase precision and safety of pelvic sarcoma surgery. In this paper we describe two patients in whom image guided surgery was applied to achieve an adequate local tumour resection of a pelvic girdle sarcoma and a soft tissue sarcoma invading the pelvic bone with a review of the current literature.

Methods

Patient selection

At the University Medical Centre Groningen, we treat 5–10 patients with pelvic sarcomas of different histological origin and anatomic location, yearly. All these cases are presented at the weekly sarcoma conference. This is a multi-disciplinary meeting that consist of surgical, medical, and radiation oncologists, a radiologist and pathologist, as well as a orthopaedic, thoracic, and neurosurgeon. In this meeting the use of IGS was suggested by the neurosurgeon for the specific patients herein presented.

The system set-up

Two patients were operated upon with the help of a commercially available navigation system (Vector Vision®, BrainLAB, Heimstetten, Germany). The Vector Vision® spine software is only intended for spinal surgery, but we used it for navigation in the pelvic area. BrainLAB does not support this use, because the software is not designed to be used outside spinal surgery. There is ample experience in using this system at the department of neurosurgery in our hospital, but until now it was never used for pelvic sarcoma surgery. This is why, along with the surgical oncologist, a neurosurgeon and an engineer from the department of neurosurgery participated in these two operations. In general, most pelvic surgery can be performed without the need for intra-operative guidance.

The Vector Vision® navigation system consists of two infrared cameras connected to a computer with a touch screen (Fig. 1). The cameras emit infrared flashes which are reflected by passive marker spheres mounted on the surgical instruments, making it possible to visualise their position on the computer screen. Pre-operative imaging of the relevant anatomical site was performed with a 16-slice helical CT-scanner (Sensation 16, Siemens AG, Berlin, Germany) with a 3-mm slice thickness, according to a special BrainLAB protocol. The reference array was attached to a bone screw placed in the iliac crest of the pelvis (Fig. 2).

Figure 1. Vector Vision® navigation system with computer screen and infrared cameras.