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Potential of a new laser target system for percutaneous CT-guided nerve blocks: technical note

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Abstract A prototype of a laser target device was used for CT-guided nerve blocks in a preliminary series of nine interventions. The system provides guidance from any possible approach. High accuracy of needle insertion was achieved; the average deviation of the planned from the actual angle was 1.4°. The target device is valuable for facilitating minimally invasive therapy and can decrease the time required for the procedure.

Key words Nerve block, technology · Computed tomography

Introduction

Spinal nerve block is used for preoperative evaluation of the clinical significance of disc prolapse in patients with changes in multiple segments or an equivocal herniated disc [1]. It is also an alternative therapeutic option for patients, in whom conservative measures prove ineffective and surgery is contraindicated. It can improve the quality of life in patients with advanced malignant disease. CT guidance enables controlled placement of a needle in the region of the root, with a low complication rate [2]. However, spinal nerve block can be difficult, as the target is small and deep. Sometimes multiple needle manipulations and control scans are required to ensure correct needle placement. A long procedure can be exhausting for the patient and increase the complication rate. Employing a target device for CT-guided interventions improves accuracy and can reduce the time required [3, 4, 6]. Different guidance systems have been developed, some of which have to be permanently installed in the CT room or mounted on the gantry [5–7, 10]. If the device is fixed directly at the front of the gantry, the CT table cannot be moved out completely for the needle insertion, because the entry point on the skin must remain within reach of the guidance system. Hence, access to the patient is restricted. In many systems the desired angle can be adjusted only in the transverse plane, so that punctures with gantry tilt are not possible [5, 8, 9]. Hand-held devices often obstruct the direct view of the entry point and restrict the examiner's actions. These devices require sterilisation after use [5, 9]. Some systems are fixed on the needle and have to be detached when the target is reached [9, 11]; this can lead to jerking of the needle. We introduce a movable optical-guidance device, which operates without direct contact with the needle or skin and provides three-dimensional checks on needle insertion.

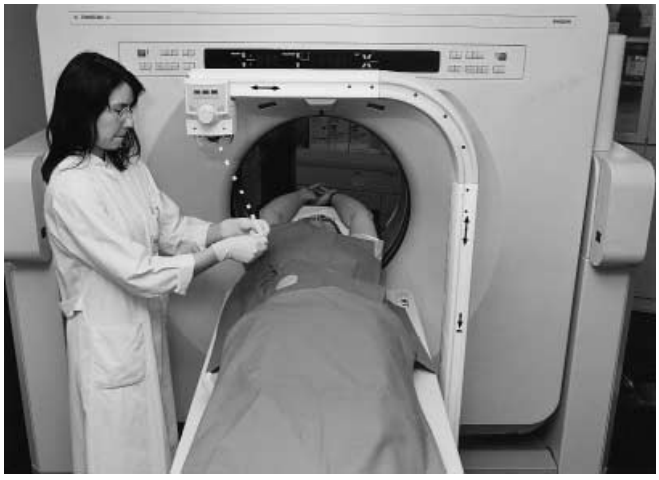

Fig. 1 Optical guidance instrument: The laser beam generator can be moved along the rail as indicated by the black arrows. The *dotted line* symbolises the laser beam. When the beam is adjusted to the planned angle and placed on the selected skin entry point, the needle can be aligned to it. The needle then points at the target and can be advanced straight ahead

Materials and methods

We performed nine nerve blocks in eight patients (three women, five men, aged 31–68 years): seven had pain due to intervertebral disc protrusion and one had chronic pain due to metastases. We used a prototype laser guidance system (SimpliCT™, NeoRad AS, Oslo, Norway) consisting of a laser unit mounted on a 90° angled rail. A red semiconductor laser (wavelength 635 nm) generates a light beam. The laser unit is housed in a movable carrier, which also contains the batteries for power supply and the control panel (Fig. 1). The carrier can be locked at any position on the horizontal or vertical parts of the rail. Puncture guidance is based on the principle that a laser beam is adjusted to the planned angle and placed above the operating field, so that it points exactly at the selected entry point on the skin. The needle is then adjusted in line with the laser beam and iserted at the planned angle, maintaining alignment with the laser.

The patients were positioned prone on the table of the CT scanner. Axial images were obtained at the level of the appropriate spinal segment, to plan the procedure. A scan showing a safe route to the nerve, where it exits the neural foramen, was chosen. A radiopaque grid was placed on the skin over the desired skin entry-point. The scan was repeated and the grid served for orientation. A line from the entry point to the area of the root was defined on the CT monitor with electronic calipers (Fig. 2 a). The distance between these two points and the angle of the desired route to the horizontal were displayed on the monitor.

Then the entry point was marked on the skin, using the positioning light of the CT system and the radiopaque grid. The skin was disinfected and local anaesthesia was given in the standard fashion. Then, the laser guidance system was placed orthogonal to the CT table. The table was moved out of the gantry so that the laser beam matched the level of the selected entry point. The desired angle was set on the control panel of the target device and the laser carrier was moved on the rail until the laser beam pointed to the entry point, which had been marked. The carrier can be used on the horizontal or vertical part of the rail, according to the desired angle (Fig. 1). Angles from + 45° to –45° to the vertical were set with the carrier on the horizontal arm, while larger angles were set with the laser on the vertical stand. The patients were then asked to hold their breath in the same natural expiratory position as used to obtain the scan for planning the procedure. A 22 gauge 3.5 or 5 inch needle was employed. The depth of insertion was marked on the needle according to the measured length of the path. The needle was inserted through the skin and angled so that the laser beam was visible on its end. It was then advanced while being rotated, maintaining the angle so that the laser beam was always visible on its end. When the needle was inserted to approximately two thirds of the entire tract a scan was obtained to confirm the correct angle and position. Finally, the needle was advanced to the target region and a mixture of 3 ml bupivacaine, 1 ml celestan and 0.5 ml contrast medium was injected. Images were obtained to document the distribution of the contract medium.

Results

All nine nerve blocks were successful. No complications were encountered. The mean difference between the planned and actual angles was 1.4° (range 0–4°). Re-insertion of the needle was not required in any case. The depth of needle insertion was on average 5.4 cm (range 4–10 cm). The procedures took 30–40 min on average; the mean time between planning the puncture and completion of needle placement was 8.4 min (range 5–17 min). The operators found the laser target device easy to handle and useful for the procedure.

Discussion

Accurate positioning of the needle is essential for successful CT-guided percutaneous interventions and especially for nerve blocks. CT offers clear demonstration of the target area and the surrounding structures and accurate measurement of the path desired in the range of submillimetres and degrees. Localisation of the proposed entry point on the skin is easy, using orientation markers and the positioning lights of the CT system. In contrast, achieving the desired angle for needle insertion remains a source of error, even for an experienced interventionist. Guidance systems help to transfer the value measured to the puncture site. So far, various systems using different techniques have been developed. An important requirement for daily clinical use of such a system is the possibility to integrate it easily into the procedure. Consequently, the fundamental criterion is optimal adaptation to the intervention. The advantages of the laser system described are precise guidance in-plane and for compound angles with gantry-tilt. The system is movable and operates touch-free. Complete freedom in the operation field is therefore maintained. The CT table can be moved out completely, allowing comfortable access to the patient. As the device is not fixed to the needle, the elastic properties of the latter are