Clinical value of C-arm computed tomography navigation technology in performing percutaneous vertebroplasty

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Purpose

To evaluate the value of SIEMENS Syngo DynaCT 3-D navigation system guidance in performing percutaneous vertebroplasty.

Methods and Materials

Material and Methods

15 patients (11 males and 4 females, median age 55.0 years, range from 41.0 to 65.0) with metastatic tumors of bone were enrolled in performing percutaneous vertebroplasty under the guidance of SIEMENS Syngo DynaCT 3-D navigation system from November 2009 to May 2011. 21 osteolytic lesions were found in 15 lumbar vertebrae, 3 thoracic vertebrae and 1 sacral bone. Local DynaCT technique was used before procedures to determine the continuity of cortical bone and the results were compared with those of spiral CT. Puncturing lesions were under the guidance of Syngo DynaCT 3-D navigation system during procedures, and observed bone cement dispersion situation under real-time DSA. Cement leakage was determined under DynaCT after procedures.

DynaCT imaging technique

DynaCT images of the phantoms and patients were acquired with an angiography flat detector C-arm (Axiom-Artis dBA VB31C; Siemens Healthcare, Forchheim, Germany) using the 8sDR preset (DynaCT®; Siemens Healthcare, Forchheim, Germany) with an acquisition time of 8 s, a total projection angle of 240°, projection increment 0.5°, 1-k matrix, zoom factor 0, field of view 480 mm and a system dose per pulse of 0.36 µGy. With the detector used, the volume covered had a cylindrical shape with a height of 185 mm, a diameter of 225 mm (transverse and sagittal range) and a voxel size of 0.4 mm. All patient CACT examinations were performed without breath-hold. The time from the end of the data acquisition to the presentation of cross-sectional images on the reconstruction workstation (syngo X Workplace, VA72A; Siemens Healthcare, Forchheim, Germany) ranged from 43 to 45 s. syngo iGuide Needle Guidance makes it possible to plan the insertion direction of a needle in the 3D volume on syngo Workplace and simultaneously display the needle path on the Live monitor of Artis.

iGuide Needle Guidance procedure:

Step 1: Preparations for Needle Guidance: Position the region of interest in the isocenter. Perform a 3D acquisition, and the 3D acquisition data is sent automatically to the workstation, is reconstructed there and is loaded in the Inspace task card.
Step 2: Check Path and Check Views: To perform and monitor the planned needle procedure, three system positions are necessary: 1 Bull's Eye View: In this system position the C-arm is angulated in the same direction as the planned path. The central X-ray beam is aligned with the planned path. This view is used to determine the skin entry point and to align the needle (Fig.1-a, Fig.2-a).

![Fig. 1](image)

Fig. 1: Fluoroscopic images after placement of needle into phantom along graphics of planned path. Purple circle enhances visualization of skin entry site (purple dot) A. A-C Entry point view(A), Progression view(B), and random C-arm position(C) are shown.

References: J. De-chao; Zhengzhou, CHINA

2 Progression view: These two system positions are used for monitoring the needle progression. Initially they are automatically selected by the system. They provide a lateral view to the planned needle path (Fig.1-b, c).

Step 3: Progress Needle: Moving to Bull's Eye View and Find the skin entry point under 3D navigation system. Adjust the direction of the needle under fluoroscopy, i.e. move the end of the needle until the projected image of the needle in the fluoroscopy image is only a point. Then, Start to progress the needle under fluoroscopy control until the planned target point is reached (Fig.2-b,c)
**Fig. 2:** Fig.2: a: DynaCT image with graphics shows planned needle path (yellow line) into L3 vertebral body. The yellow cross indicates skin entry site, which on 90° tangent (progression view) appears as a line. Red point is actually indicating target site, which on 90°tangent (progression view) appears as a line. b1: With C-arm in entry point view, live fluoroscopy superimposed over DynaCT slice allows identification of proper skin entry site (tip or circle). b2: With C-arm in progression view, needle is advanced under live fluoroscopy (superimposed on DynaCT slice) along user-defined trajectory graphics (white line). C: Multiplanar DynaCT projections show precise correlation of needle under the guidance of 3-D navigation system.

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Vertebroplasty Technique (Fig.3)
Vertebroplasty was performed using a bilateral transpedicular approach with 13-gauge bone biopsy needles placed into the anterior one fourth of the vertebral body. The procedure was performed under biplane fluoroscopic control with the patient under conscious sedation and local anesthesia on an inpatient basis. Once the needles were placed in the vertebral body, liquid and powder polymethylmethacrylate was mixed with 15 g of barium sulfate. The cement was relatively difficult to inject through the 11-gauge needle using a 1-mL syringe. Under biplane fluoroscopic guidance (primarily lateral), the cement was injected alternately through the needles. Injection was continued until the vertebral body was filled toward its posterior 25% or until there was notable leakage. The amount of cement injected ranged from 2.5 to 6 ml (mean, 3.68 ml). The patient was lying prone on the angiographic table during the injection and remained in that position until the cement had completely hardened (#15 minutes), at which point he or she was transferred to a regular bed. The patients were routinely discharged from the hospital 3-5 days after the treatment. There were no complications in any patients at the time of hospital discharge.
Results

The bone cortex continuity was identical between the results of Pre-operative DynaCT and those of spinal CT. All 21 local lesions were punctured in one time, and puncture success rate was 100%(21/21). The amount of cement injected varied from 2.5 ml to 6.0 ml with a mean of 3.68 ml. Cement leakages was found in 7 local lesions (33.3%), Of these 7 cement leakage, 3 had peri-vertebral soft tissue leakage, 2 had venous plexus leakage, 1 had intervertebral disc leakage, and 1 had spinal canal leakage in 1 case. Complete pain relief (CR)was reached in 8 patients and partial relief#PR#in 4 patients with total effective rate of 86.7%.

Conclusion

Syngo DynaCT 3-D navigation puncture system incorporates the DSA real-time perspective and spiral CT imaging for accurate positioning puncture, shorten the positioning time and can observe the Cement leakages , which should be promoted in our clinical practice.

References


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