Purpose.
To conduct computed tomography (CT)-guided puncture exactly and safely, we newly developed a laser guiding puncture system that can be used in a commercially available CT scanner.

Materials and methods. The laser-guided CT puncture system is built on the CT table with an aluminum frame. Preliminary simulation tests were conducted using two models representing the body and nodular lesions, and puncture procedures were carried out for 15 patients using this system.

Results. The mean distance and standard deviation from the center in simulation experiments conducted using this puncture system were $2.95 \pm 1.20$ mm for operator A and $3.52 \pm 1.12$ mm for operator B. There was no statistically significant difference between the operators ($P = 0.40$) or the angles ($P = 0.32$). For five lung biopsy patients, the distance from the target point planned before biopsy to the actual last puncture point was 0–8 mm. For 10 percutaneous vertebroplasty (PVP) patients (two performed in Th11, one in Th12, five in L1, two in L2), the plan before the puncture procedure was to pass the needle through the vertebral pedicle in all cases. The distance between the planned target point and the actual last puncture point was 0–5 mm.

Conclusion. This system has the potential to accomplish the CT-guided puncture procedure safely and accurately.

Key words
Biopsy · Percutaneous vertebroplasty · Laser · Computed tomography · Technology
system weighs approximately 5 kg and is structured so it can be mounted temporarily or permanently on the outer frame of the CT bed (it takes only a few minutes to attach it). A small laser radiation device is installed on a pipe situated horizontally on the CT bed. The laser beam can be directed to the surface that is horizontal to the CT slice, and it can incline 40° from the perpendicular to the XY plane and 15° from the perpendicular to the XZ plane (Fig. 1). We used a laser device that had a 1-mm lens and a circular beam.

Puncture method

First, the position of the target lesion was confirmed using a method similar to the conventional CT-guided puncture method. The bed was then moved so the laser beam was directed on the puncture target on the body surface. Next, the point of the needle was brought in contact with the puncture target on the body surface where the laser beam was directed. With the needle tip on this point, the trigger of the needle was aligned exactly with the laser beam. The puncture needle was then advanced while maintaining its position and direction. When the needle was advanced a certain distance while the laser beam was directed on the center of the trigger, the needle tip hit the center of the target lesion. This laser-guided puncture procedure was performed for artificial phantom lesions and in 15 clinical cases.

Simulation experiments

Simulation experiments were conducted to confirm the straight advance of the needle using both laser guidance and the free-hand technique. A dome-shaped semicircular object with an outside diameter of 20 cm, an inside diameter of 3 cm, and a width of 5 cm was constructed of clay. A disk of clay with a diameter of 10 mm was placed at the center of the object to simulate an artificial nodular lesion (Fig. 2). The semicircular object was punctured three times each at 0°, 20°, 40°, 20°/15°, and 40°/15° vertically under laser guidance. Two radiologists (A and B) participated in this experiment. Radiologist A had 17 years of experience, and radiologist B had 3 years of experience.

Laser-guidance procedure

First, the laser was directed to the center of the 10-mm artificial lesion. Then the artificial lesion was covered with the dome-shaped object described above. The puncture needle was advanced, targeting the laser beam on the surface of the dome-shaped semicircular object.

Free-hand procedure

For the free-hand procedure, the laser was directed to the center of the 10-mm artificial lesion using the same