Improved Pallet Design for Brain SPECT Acquisition

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A commercially available pallet has been redesigned to optimize brain SPECT image quality. Both spatial resolution and patient stability may be significantly improved by some simple mechanical adjustments.

Apart from collimator characteristics, an optimal brain SPECT acquisition geometry is strongly dependent on the ability to minimize the rotation radius. Both the patient's anatomy (especially shoulder width) and the physical dimensions of the SPECT pallet determine the actual rotation radius.

Pallet instability due to motion is a disturbing problem affecting image quality during acquisition. In our department, we frequently observe patient motion during brain SPECT studies. Even if the patient's head is restrained by the head support, acquisition artifacts are often introduced by breathing, coughing, and moving extremities. This phenomenon has been reported by our technology staff on quite a number of occasions. These artifacts are considered inherent to the original design and construction of the pallet (Siemens pallet no. 570-018373, Siemens Gammasonics, Schaumburg, IL) This report discusses simple mechanical adjustments to the pallet, which, when implemented, result in improved spatial resolution and increase patient stability and comfort.

MATERIALS AND METHODS

At our institute, brain SPECT is performed with a Siemens Orbiter system (Siemens Gammasonics, Schaumburg, IL) using a long bore collimator. The major advantage of a long bore collimator over a standard LEAP collimator is the long bore collimator's reduced rotation radius (ROR), which results in improved spatial resolution (ROR LEAP collimator: ± 22 cm; ROR long bore collimator ± 14 cm) (*1*). The brain SPECT protocol consists of an intravenous (IV) injection of 1,000 mg acetazolamide (Diamox®), followed 5 min later by an IV injection of 800 MBq technetium-99m (^{99m}Tc) hexa methyl propyleneamine oxime (HMPAO). Ten minutes before administering ^{99m}Tc-HMPAO the SPECT room is darkened. Standard acquisition parameters are: 64 frames, 20 sec/frame, 360° circular rotation. The overall time for patient imaging is about 45 min.

In the original pallet configuration (Fig. 1), the SPECT pallet quite often hindered the achievement of a small rotation radius. Either the edge of the pallet underneath the head support or the width of the patient's shoulders prohibited free movement of the camera around the patient at a small rotation radius. The physical dimensions of the head holder itself was not the limiting factor; the position of the head holder with respect to the front edge of the pallet determined the minimal rotation radius.

Another problem we encountered was the bending of the pallet; this resulted in a 2–4 cm downward amplitude at the head of the pallet. The phenomenon occurred because the patient's center of gravity (point Z in Fig. 1a) was far from the mechanical fixation point A, through which the pallet acted as a lever. Most patient movement resulted in a pallet vibration with varying amplitudes between 0–10 mm. This pallet vibration induced a mechanical smoothing of the acquisition data.

A moving activity distribution with respect to the gamma camera will result in a decreasing spatial resolution. The final effect is dependent on the amplitude of the vibration and the occurrence frequency. Research is in progress to quantify these vibration artifacts in terms of reduced image quality.

The solution for both image degrading effects is simple: turn around the pallet and adjust the position of the head support with respect to the front edge of the pallet (see Fig. 1b). In order to position the head support on the pallet, holes have to be made at a distance of 15 cm from the front edge of the pallet. The original holes were made at 21 cm from the narrow edge of the pallet. Additionally, the corners of the pallet underneath the head support have to be milled in alignment with the edges of the head support.

RESULTS AND DISCUSSION

In the case of a long bore collimator, the effective lengthening of the pallet reduces the rotation radius by a mean value of 2.5 cm (n = 10). This figure was obtained by determining the rotation radius for the same patients under both geometrical conditions (Fig. 1). In the left lateral position, the distance between the collimator surface and the rotation axis was measured with a ruler. For a heavy patient,

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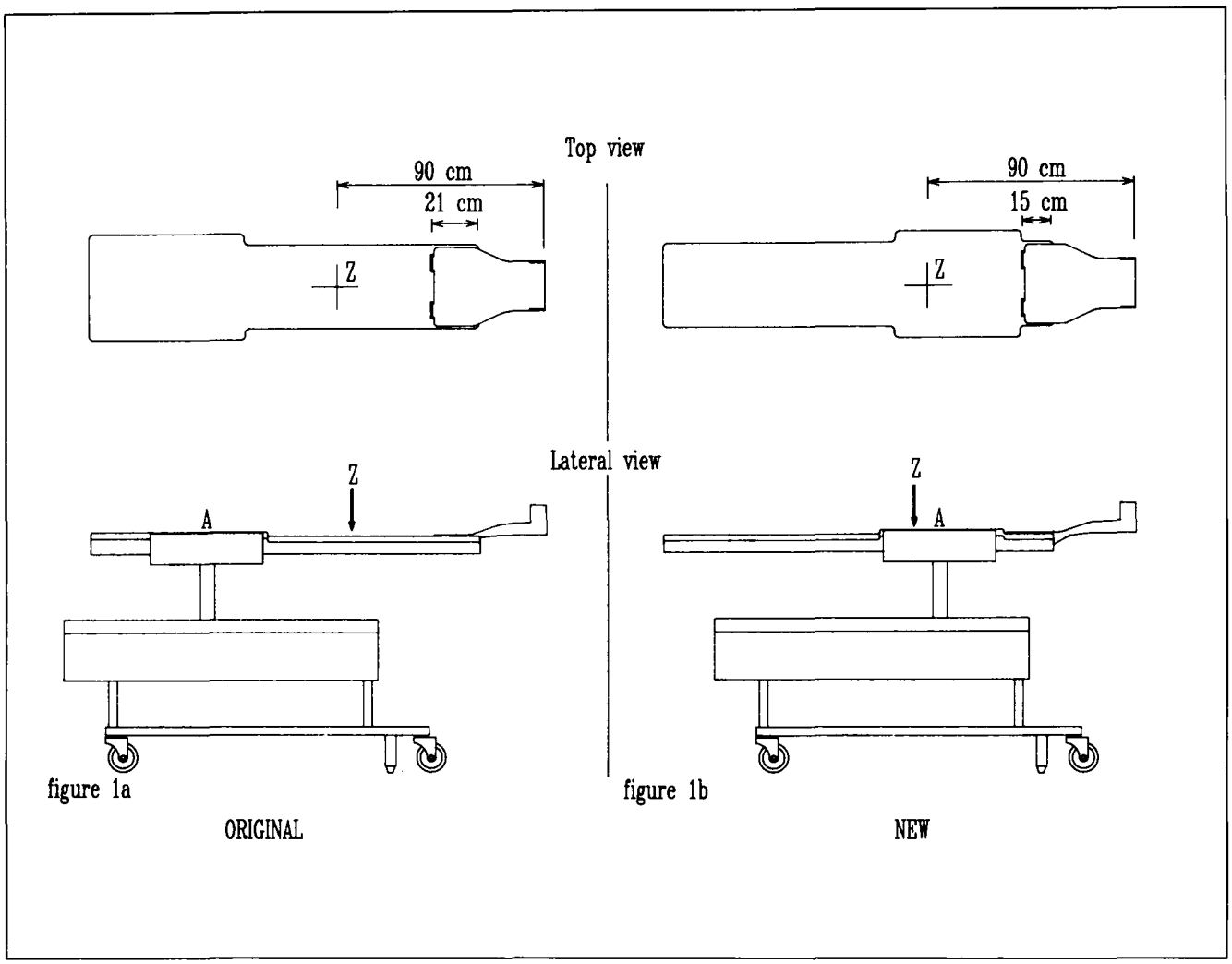

FIG. 1. Schematic layout of the original and new pallet. Z is the patient's center of gravity and A is the mechanical fixation point.

the radius reduction was 4 cm. In terms of spatial resolution, an improvement of about 2 mm is expected, leading to a system spatial resolution of approximately 10 mm.

One disadvantage of the reversed pallet geometry is that for other types of studies (cardiac, abdominal) the pallet has to be unbolted, spun around, and rebolted. However, this procedure only takes 2 min, which is quite acceptable when the overall scan time and the quality improvement in case of brain SPECT studies is considered.

In principle, any mechanical adjustment will effect the structural integrity of the pallet. However, proposed minor adjustments will not effect the safety of the modified pallet. In the original configuration when the holes are milled at the smallest part of the pallet, the mechanical strength is guaranteed by the manufacturer. The only modifications are holes milled at the broadest part of the pallet, while the patient's center of gravity is more strongly supported by the rigid central table construction. In the long run, the brain SPECT pallet should be manufactured by the supplier and approved by the appropriate agency.

Increased stability is determined by both the reduced movement of the lever on the head of the pallet and the reduced distance between the center of gravity and the mechanical fixation points of the pallet. The induced pallet vibration is negligible. An additional advantage is that the patient's upper body lies on the broadest part of the pallet; so patient comfort is notably improved.

In the case of brain SPECT studies, simple mechanical adjustments on the original construction of the SPECT pallet have resulted in improved system resolution and reduced motion artifacts.

REFERENCES

1. Mueller SP, Polak JF, Kijewski MF, Holman LB. Collimator selection for SPECT brain imaging: the advantage of high resolution. *J Nucl Med* 1986;27:1729–1738.