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Use of video goggles for patient distraction during PET/CT studies of school age children

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Abstract

Objectives: For PET/CT imaging in children, (1) to evaluate the effectiveness of video goggles for patient distraction, and (2) to evaluate CT and PET artifacts caused by the video goggles.

Methods: Video goggles with small amounts of internal radioopaque material were used in this study. During whole body PET/CT imaging, 30 unsedated patients age 4 to 13 years watched videos of their choice using video goggles. 15 patient studies were performed on a PET/CT scanner installed in 2006 and 15 were performed on a PET/CT scanner installed in 2013. Fused PET/CT scans were reviewed for evidence of head movement. The presence and severity of streak artifacts was reviewed on each CT and PET scan of the head. CT exposure settings were recorded for each scan at the anatomic level at which the goggles were worn during the scan.

Results : Only one of 20 patient scans had evidence of significant patient head motion. Two of 30 scans had minor co-registration problems due to motion and 27 of 30 demonstrated very good to excellent co-registration. Using a 2006 PET/CT scanner, 2 of 14 evaluable localization CT scans of head demonstrated no streak artifacts in brain tissue, 6 of 14 had mild streak artifact and 6 of 14 had moderate streak artifact in brain. Mild streak artifact in bone was noted in 2 of 14 studies. For the 2013 scanner, seven of 15 studies had mild streak artifact and 8 of 15 had no streak artifact in brain tissue, while there was no streak artifact in

bone in all 15 studies. There were no artifacts on FDG PET brain images attributable to the goggles in any of 30 studies. Average CT exposure parameters at the level of orbits were 59% lower on the 2013 scanner compared to the 2006 scanner.

Conclusions : Video goggles may be used successfully as a patient distraction device for PET with localization CT, with no significant degradation of PET brain images and CT skull images. The amount of artifact on brain tissue images varies from none to moderate and depends on the CT equipment that is used.

INTRODUCTION

High quality pediatric nuclear medicine imaging requires that a child or adolescent hold still during the acquisition of nuclear imaging procedures, including PET, PET/CT, SPECT, SPECT/CT and planar single photon imaging. For hybrid imaging, notably PET/CT and SPECT/CT, the patient must remain still, not only to prevent degradation of the 3-dimensional PET or SPECT imaging, but also to keep the scintigraphic images in precise co-registration with the localization CT images that are acquired after the 3-dimensional scintigraphic images. Some children may become uncooperative because of fear or anxiety, and other children and adolescents simply may have difficulty holding still for an acquisition period that may be long as 20 or 40 minutes (*1*). As a method of distracting the patient from imaging process, video goggles have been successfully used during MRI imaging in order to help the patient hold still (*2-4*). Video goggles present both visual and audio distraction to the child. An age-appropriate movie of the patient's choice can focus the patient's attention during imaging, resulting in better co-operation, making it easier for the patient to hold still.

Video goggles contain minimal amounts of metal. The amount of metal may be so small that it may be possible to acquire head images during PET/CT that do not contain significant artifacts. The purpose of this paper is to evaluate the use of video goggles for distraction of children and adolescents during whole body

PET/CT, and to evaluate the frequency and severity of CT and PET artifacts caused by the video goggles.

METHODS

A video goggle set containing minimal amounts of internal radioopaque material was identified and used in this study (Vuzix® 1200DX, West Henrietta, New, York). A child life specialist provided developmentally appropriate sensory preparation for patients prior to imaging in order to lessen any fear or anxiety, ensure that each child and adolescent understood what he or she would experience and highlight the importance of holding still. 30 [F-18]FDG PET/CT studies were reviewed retrospectively, acquired while patients age 4 to 13 years (median age 9, mean age 8.8 years) watched videos of the patients' choice using video goggles. Studies were excluded if the video goggles had slipped out of position from directly in front of the eyes. 15 patient studies were performed on each of 2 PET/CT scanners, one PET/CT scanner installed in 2006 (GE DSTe, Milwaukee, WI) and the other scanner installed in 2013 (Philips Ingenuity, Cleveland, OH). PET and localization CT axial sections were reviewed individually and with PET fused to CT. Streak or other artifacts caused by the video goggles were noted and evaluated for severity. CT exposure settings were recorded for each scan for the axial scan level at which the goggles were worn during the scan. Images were also reviewed for evidence of patient motion including inaccurate co-registration.

The study was a retrospective review of clinical data. The study was approved the Instutitional Review Board (IRB) at the authors' hospital, where the patients were imaged. Informed consent was waived by the IRB,

RESULTS

All 30 examinations were completed.

Accuracy of Co-Registration of PET and CT

Of 30 scans, only one scan had evidence of significant patient motion of the head that precluded accurate co-registration of PET and CT in the head and neck. Two of 30 scans showed minor co-registration problems due to motion and 27 of 30 demonstrated very good to excellent co-registration. 29 of 30 scans were further evaluated, excluding the scan with the most movement between PET and CT.

Streak Artifact

Fourteen of the 15 studies imaged using the 2006 PET/CT scanner could be evaluated. Two of 14 localization CT scans of head demonstrated no streak artifact in brain tissue (viewed at soft tissue windows), six of 14 had mild streak artifact and 6 of 14 had moderate streak artifact in brain. Mild streak artifact in bone was noted in 2 of 14 studies (viewed at bone windows).

For the 2013 PET/CT scanner, 7 of 15 localization CT studies had mild streak artifact in brain tissue and 8 of 15 had no streak artifact in brain tissue, while there was no streak artifact in bone in all 15 studies performed on that scanner.

There were no artifacts on FDG PET brain images attributable to the goggles in any of 29 evaluable studies (Figs. 1 and 2).

On the 2006 vintage PET/CT scanner, the axial sections analyzed were acquired at 120 kVp, with an average mAs of 56. On the 2013 vintage scanner, scans were acquired at 100 kVp, average mAs 30 in 12 patients, and at 120 kVp, average mAs 21 in the remaining 3 patients. Taking into account both kVp and mAs, average CT exposure parameters at the level of the orbits were calculated to be 59% lower for the 2013 scanner compared to the 2006 scanner.

DISCUSSION

Video goggles were used successfully as a patient distraction tool for children and early adolescents undergoing PET/CT studies. Providing the patient with an opportunity to choose and watch a preferred movie as a distraction during imaging encourages and assists with holding still. Patients then can focus their attention on the movie. In only one of 30 imaging examinations was there significant misregistration between PET and CT images.

In other research studies where video goggles were used during MRI acquisition, the distraction effect was greatest in the age group between 3 or 4 years of age and 10 years. In one study, the beneficial effect of using video goggles for MRI examinations was considered to be 84%. In another study, the need for sedation was reduced from 53 to 40% (*2-4*). The average estimated cost of sedation at 5 US children's hospitals in 2014 was $2,950. The reduction in time required for patient preparation and observation when sedation was avoided was 2 hours (*5*). It should be noted that medication used for sedation may affect respiratory drive, airway patency and protective airway reflexes and appropriate personnel training, equipment and monitoring are required (*6*).

There were no visible artifacts on axial PET images of the brain, although artifacts were sometimes seen on the axial localization CT images. The amount of artifact in brain tissue on axial localization CT images varied from none to moderate and depended on the CT equipment and CT exposure parameters that were used. Streak artifacts in the brain parenchyma were less common on CT images acquired with the newer model CT scanner, despite use of considerably lower CT exposure parameters (7).

CONCLUSION

Video goggles may be used as a patient distraction device for PET/CT scans performed with localization CT, with no significant degradation of PET axial brain images. CT axial brain and skull images were adequate for localization and attenuation correction. The amount of artifact in brain parenchyma and bone on axial images varied from none to moderate and depended on the CT equipment and CT exposure parameters that were used.

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FIGURE LEGENDS

Figure 1A. 7 year old imaged on the 2006 PET/CT scanner showing moderate soft tissue streak artifact when viewed at soft tissue windows acquired at (kVp 120, mAs 25).

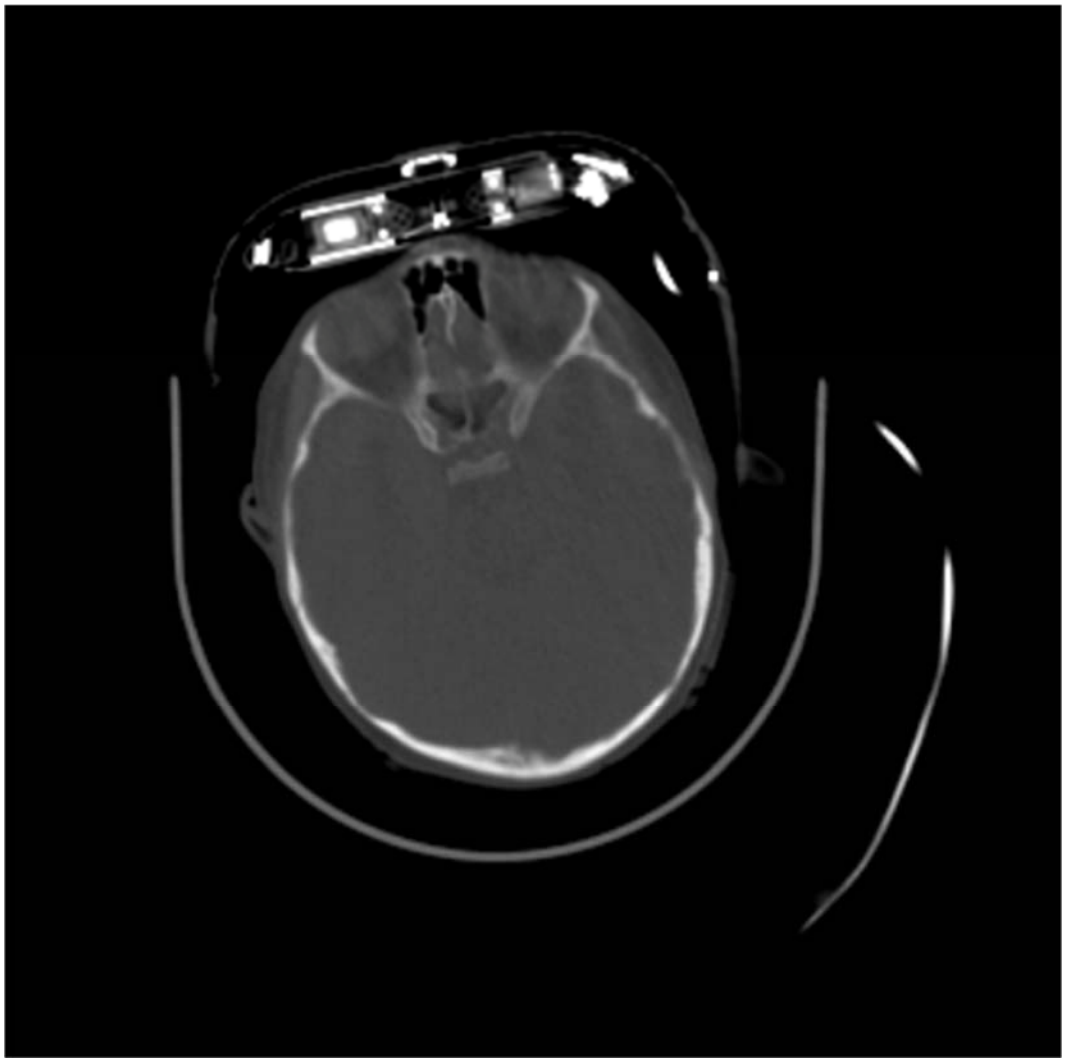

Figure 1B. The adjacent axial CT section from the same study viewed at bone windows showing very mild bone artifact.

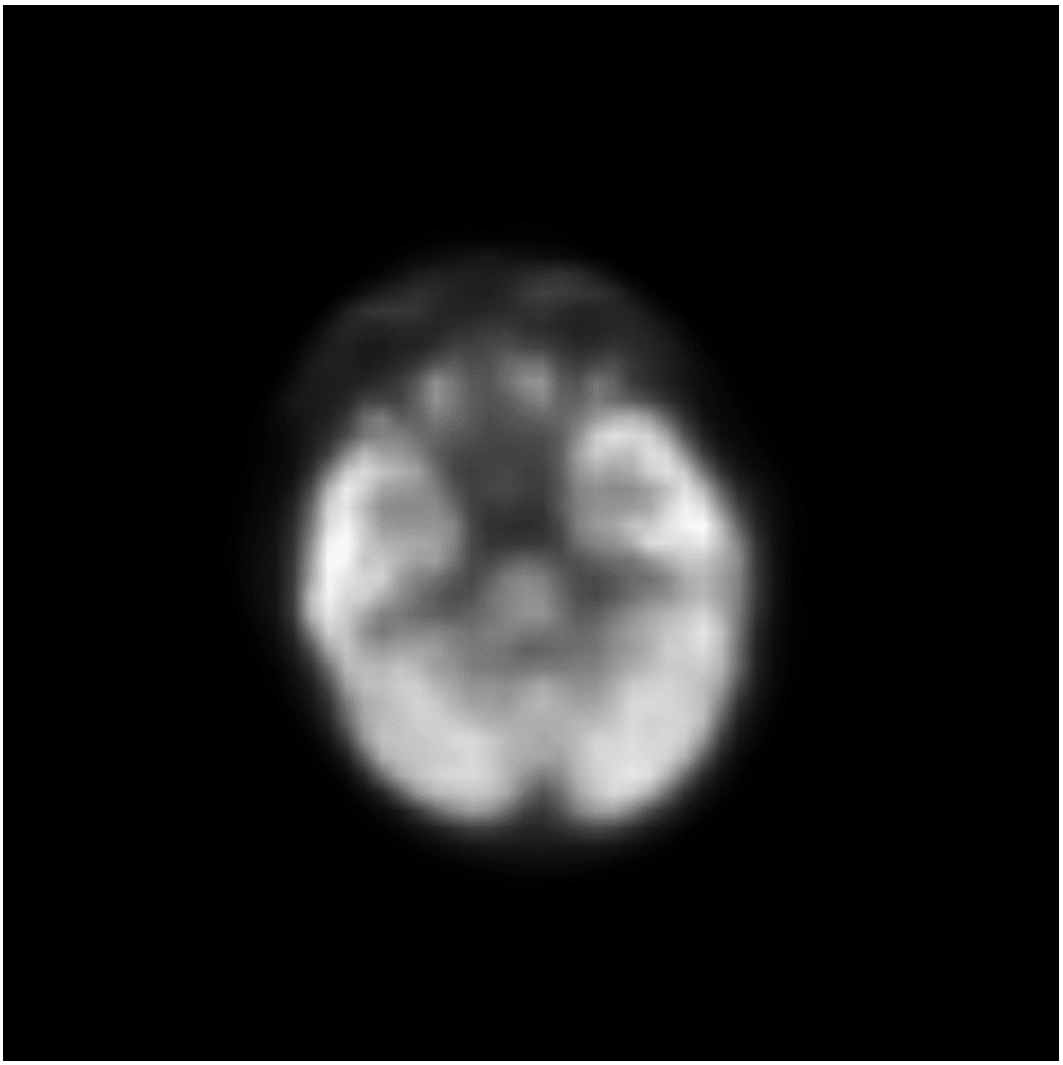

Figure 1C. PET acquisition at the same level as Figure 1B showing no artifact.

Figure 2A. 11 year old imaged on the 2013 PET/CT scanner showing minimal soft tissue streak artifact when viewed at soft tissue windows (kVp 100, mAs 13).

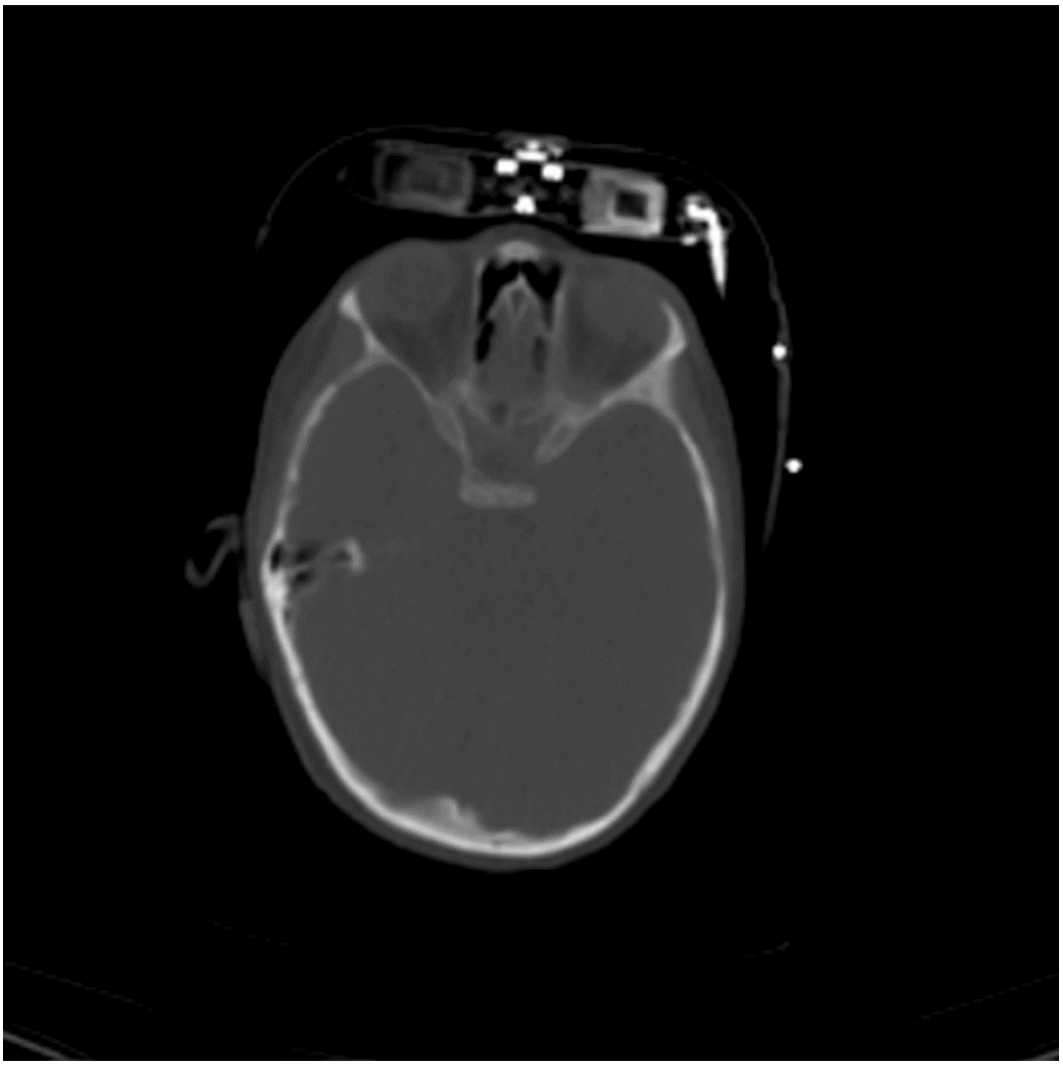

Figure 2B. The same axial section from Figure 2A viewed at bone windows showing no bone artifact.

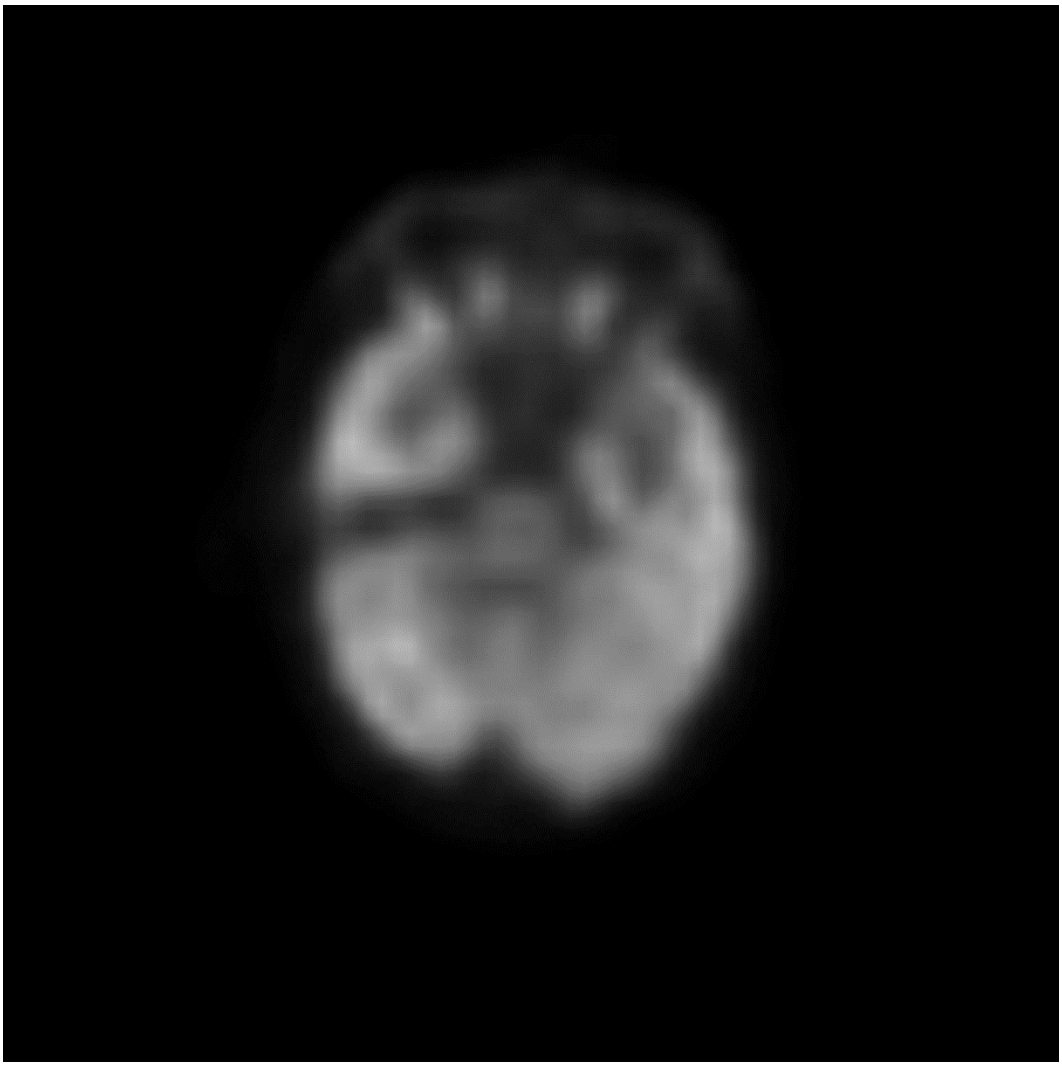

Figure 2C. PET acquisition at the same level as Figure 2B showing no artifact.