Four patients with gastrointestinal bleeding identified by a modified in vivo technique with labeled red blood cells sedimentation

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Abstract

Objective: Gastrointestinal bleeding scintigraphy (GIBS) offers the advantage of continuous monitoring of patients to localize the site of gastrointestinal bleeding. In this study, a modified in vivo labeling method with sedimentation of the labeled red blood cells (RBC) was applied to remove free technetium-99m (^{99m}Tc) and increase labeling efficiency. **Patients and Methods:** Four patients were studied. A modified in vivo RBC labeling method was used. After 10 minutes of RBC sedimentation, patients' blood plasma in the upper part of the syringe was removed, and the erythrocytes labeled with ^{99m}Tc were re-administered to the patient. Serial dynamic scintiphotos were taken during the first 60 minutes. Delayed static images were acquired up to 22 hours after injection. **Results:** The labeling efficiency of ^{99m}Tc-RBC increased up to 93%. GIBS can be performed after 20 hours post-injection and provide accurate diagnosis of gastrointestinal bleeding. No false positive findings due to free ^{99m}Tc accumulation were observed for the four patients. **Conclusion:** The modified in vivo method with sedimentation is a simple and effective way to increase the labeling efficiency and thus the diagnosis for the detection of gastrointestinal bleeding.

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Introduction

Lower gastrointestinal bleeding (GIB) has been reported to have a mortality rate of 4%, and its prevalence increases with age [1]. Gastrointestinal bleeding scintigraphy (GIBS) is able to characterize and stratify the risk in patients with lower GIB. The technetium-99m (^{99m}Tc)-labeled sulfur colloid and ^{99m}Tc-labeled red blood cells (RBC) have been used for GIBS. Clinical studies demonstrated that the results of ^{99m}Tc-RBC are superior to those of ^{99m}Tc-sulfur colloid in term of the slow clearance of ^{99m}Tc-RBC from the blood pool [2, 3]. In addition, ^{99m}Tc-RBC scintigraphy can be acquired continuously, making it capable of monitoring patients with intermittent bleeding [4].

Various methods have been proposed to label RBC with ^{99m}Tc, including in vivo, modified in vivo, and in vitro procedures. The modified in vivo method is most commonly used with a labeling efficiency of about 85%-90% [5]. The presence of free ^{99m}Tc in blood is a common pitfall for interpretation of ^{99m}Tc-RBC scintigraphy results due to false positive findings related to ^{99m}Tc secretion within duodenum and renal excretion in the urine.

Sedimentation is a physical process of settling denser substances to the bottom of the container by gravity. The heavier erythrocytes can thus be separated from the lighter plasma and free ^{99m}Tc, so that the amount of unwanted free ^{99m}Tc can be decreased. Herein, we presented four cases of GIBS using the modified in vivo labeling method with additional RBC sedimentation.

Patients and Methods

Four patients (3 males and 1 female) with a mean age of 70.3±8.4 years were enrolled in this study. Their signed informed consents were obtained. The clinical indication for GIBS included tarry stools, anemia, and ischemic bowel. The procedure of GIBS was carried out in accordance with the SNMMI procedure standard and the EANM practice guidelines [6].

Each patient was injected intravenously with 1mg stannous pyrophosphate (Sn-PYP), which then circulated for 20 minutes. A total amount of 10mL blood was collected in a heparin-rinsed syringe and mixed with 740-910MBq $^{99m}TcO_3$-. After 5 minutes of incubation and 10 minutes of sedimentation, blood plasma in the upper part of the syrin-ge was removed, and the erythrocytes labeled with ^{99m}Tc in the bottom part were re-administered into the patient (Figure 1). A dynamic GIBS acquisition of the abdomen and pelvis was performed with a 128x128 matrix. Images were acqu-ired for 20s/frame. Serial dynamic scintiphotos were taken during the first 60 minutes, and delayed static images were acquired during 2-7 hours and 21-22 hours after the injection.

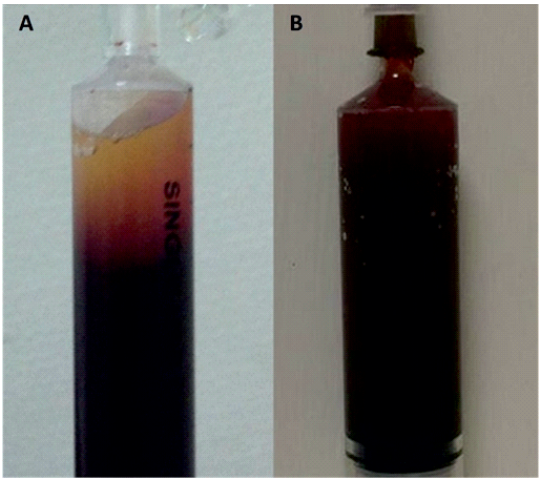

Figure 1. Sedimentation of labeled RBC in the syringe (A) and plasma removed (B)

Results

Four of our cases are described in Figures 2-6.

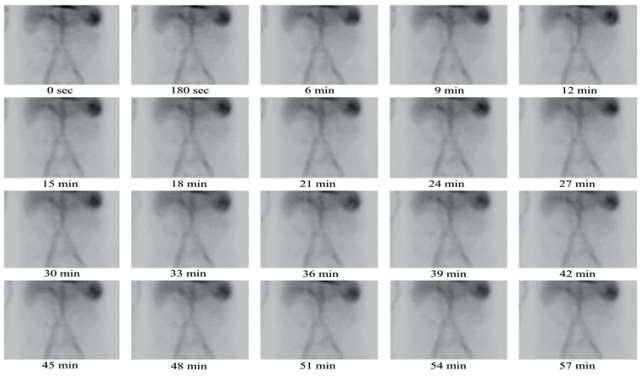

Figure 2. Cinematic display of a 60min dynamic study in a 58 years old male with tarry stool. Definite GIB was not detected.

Discussion

There are three ways to label erythrocytes with ^{99m}Tc: in vivo, modified in vivo, and in vitro procedures. In the in vivo method, the patient receives an intravenous injection of Sn-PYP, which is allowed to circulate for a few minutes, followed by intravenous injection of ^{99m}Tc. This technique is generally not

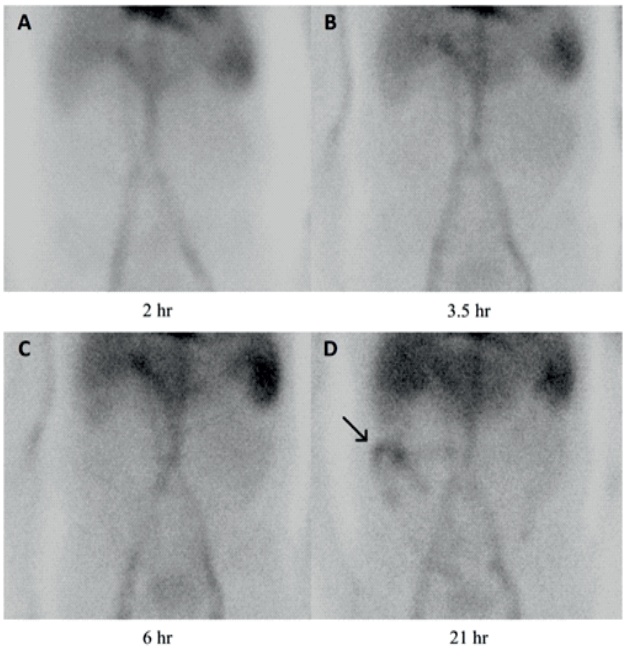

Figure 3. The patient of Figure 2. Delayed static images at 2 hours (A) at 3.5 hours (B) and at 6 hours (C) post-injection revealed no evidence of GIB. A delayed static image at 21 hours post-injection revealed radioactivity accumulation in the right abdomen (D).

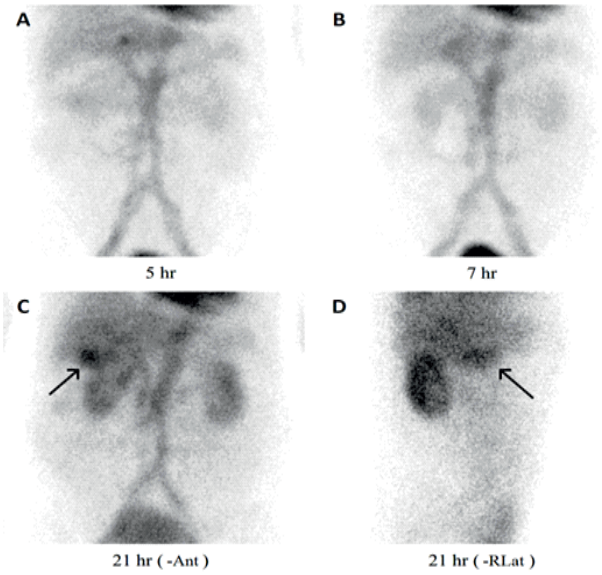

Figure 4. Delayed static images of the 74 years old male with ischemic bowl 5 hours (A) and 7 hours (B) post-injection revealed no evidence of GIB. Anterior (C) and right lateral views at 21 hours (D) post-injection revealed radioactivity accumulation in the right abdomen.

preferred because it has the lowest labeling efficiency of about 75%-80% [7]. The in vitro method involves the use of a specific commercial kit with 30min preparation time. This method has the highest labeling efficiency of 97%, which improves the target-to-background ratio and decreases the

probability that free ^{99m}Tc interferes with the interpretation of results [8]. The modified in vivo method, also known as the "in vivtro" method, begins with intravenous injection of Sn-PYP. Subsequently, blood is drawn from the patient and mixed with ^{99m}Tc. This method has a labeling efficiency of about 85%-90% [5]. In this study, we proposed using the modified in vivo method with labeled RBC sedimentation. The labeling efficiency is increased to 87%-93%. This modification prolongs testing for GIBS up to 22 hours without being influenced by free ^{99m}Tc. Gastrointestinal bleeding scintigraphy commonly requires serial images. If no bleeding site is identified within the first 60 minutes, delayed images are usually acquired [9]. False-positive readings may be due to aneurysms, varices, inflammation, and tumors [10, 11]. Hot spots in GIBS may be caused by the gastric uptake rather than gastric bleeding.

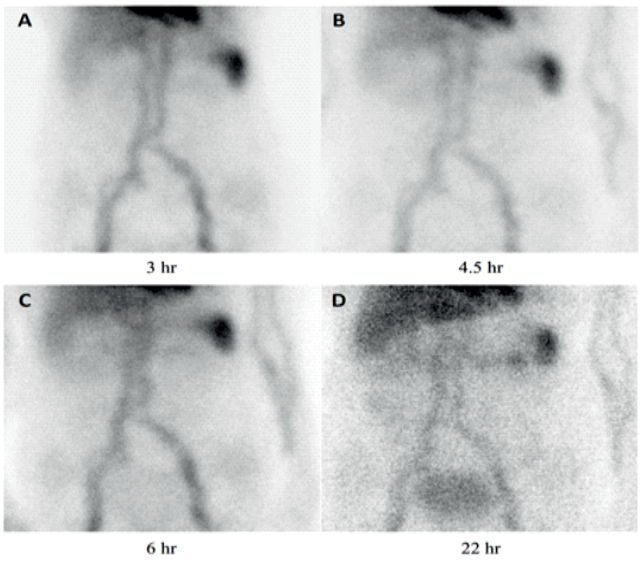

Figure 5. Delayed static images of a 77 years old female with anemia and myelodysplastic syndrome after 3 (A), 4.5 (B) and 6 hours (C) post-injection. The delayed image at 22 hours post-injection showed curvilinear faint radioactivity in the colon (D). The location of the bleeding was supposed to be proximal to the ileocecal valve; however, the exact position cannot be located.

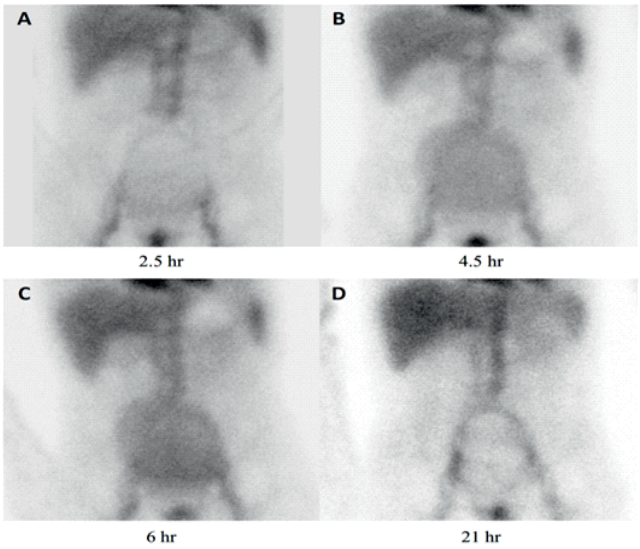

Figure 6. Delayed static images of the 72 years old male with persistent anemia after 2.5 (A), 4.5 (B), 6 (C) and 21 hours (D) post-injection revealed no evidence of GIB. Distended urinary bladder was also observed at 6 hours, and no artifact caused by free ^{99m}Tc secretion was observed for up to 21 hours post-injection.

The major advantage of the proposed method is its simplicity and effectiveness. No additional equipment and specific commercial kits are required to elevate the labeling efficiency. The GIBS results of the four patients showed satisfactory diagnostic performance, and subsequently no false positive findings were observed. Some limitations of this study are: the limited number of patients, the different selection criteria of our patients, the absence of a control group, the fact that we did not use a mild centrifugation for comparison and that we did not test the free $^{99m}TcO_4^-$ of a blood sample taken in vivo or in vitro. Further studies are required to investigate the sensitivity and specificity of GIBS with the proposed method.

The authors declare that they have no conflicts of interest

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