Uterine Blush in Multiphase Bone Imaging

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Uterine visualization was found as a transient finding in the early phases of the biphasic and triphasic bone scans in 29 of 29 postmenarchial adolescent and young adult females studied regardless of phase of the menstrual cycle. This observation differs from reports of uterine uptake in Meckel's scanning where visualization occurred only in the menstrual or secretory phases of the cycle. None of 12 control patients (six males and six premenarchial females) showed intrapelvic activity on the blood-pool images. The accumulation of radiotracer in the uterus should be expected as a normal transient physiologic phenomenon in young women after menarche.

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The uterine blush (focal accumulation of radionuclide presenting superior to the bladder) has been described as causing a false-positive result when scanning with technetium-99m (^{99m}Tc) pertechnetate for the detection of Meckel's diverticulum (*1*). We have found this is a common occurrence on the multiphase bone scan in postmenarchial females. This accumulation has not been previously described in bone scintigraphy.

MATERIALS AND METHODS

At our institution, a pediatric orthopedic hospital, the pelvic scintigrams of 41 adolescent and young adult patients who had a two-phase (blood-pool and delay) or three-phase (flow, blood-pool, and delay) study were evaluated for a coincidental focal accumulation of radiotracer superior to the bladder in the region of the uterus. Twenty-nine patients were postmenarchial females ranging in age from 12.8 to 29.7 yr (mean 20.1 yr). Detailed menstrual histories were obtained to establish cycle length, regularity, and duration of the menstrual phase. From this information, the phase of the cycle at the time of the scan was determined. Twelve control patients were included in the study. The controls included six males and six premenarchial females ranging in age from 6.3 to 14.4 yr (mean 11.1 yr).

The majority of the patients were being evaluated for either low-back pain or hip pain, which required multiphase scintigrams that include the pelvic area. A requirement for inclusion in the study was that anterior and/or posterior blood-pool images had to have been acquired prior to the appearance of radioactivity in the bladder. This eliminated the potential for masking of uterine activity by an overlying bladder. Both biphasic and triphasic studies were obtained on a computer-assisted gamma camera equipped with a high-resolution, parallel hole collimator. Each patient received an i.v. bolus of [^{99m}Tc]methylene diphosphonate (MDP) determined on the basis of body weight (200 μCi/kg). When a flow study was performed, it was acquired as 24 5-sec images (Fig. 1). Blood-pool images (500,000 to 1,000,000 counts per image) were performed almost immediately following the injection or vascular phase (Fig. 1). The delayed images were begun ~2 hr postinjection of the radiotracer (Fig. 1).

In assessing the multiphase images, activity in the pelvis was characterized as uterine when it appeared transiently on the flow and/or blood-pool images, disappeared on the delayed images, and had a discrete ovoid shape. The delayed images showed the bladder to visualize inferior to the region of the uterine blush. If present, the intensity of the uterine blush on the anterior or posterior images was compared to the perineum and visually characterized as greater than, equal to, or less than the perineal activity.

RESULTS

In the 41 studies reviewed, the six male patients exhibited no pelvic activity as expected (Fig. 2). One premenstrual female exhibited transient pelvic activity on the flow images which disappeared on the blood-pool

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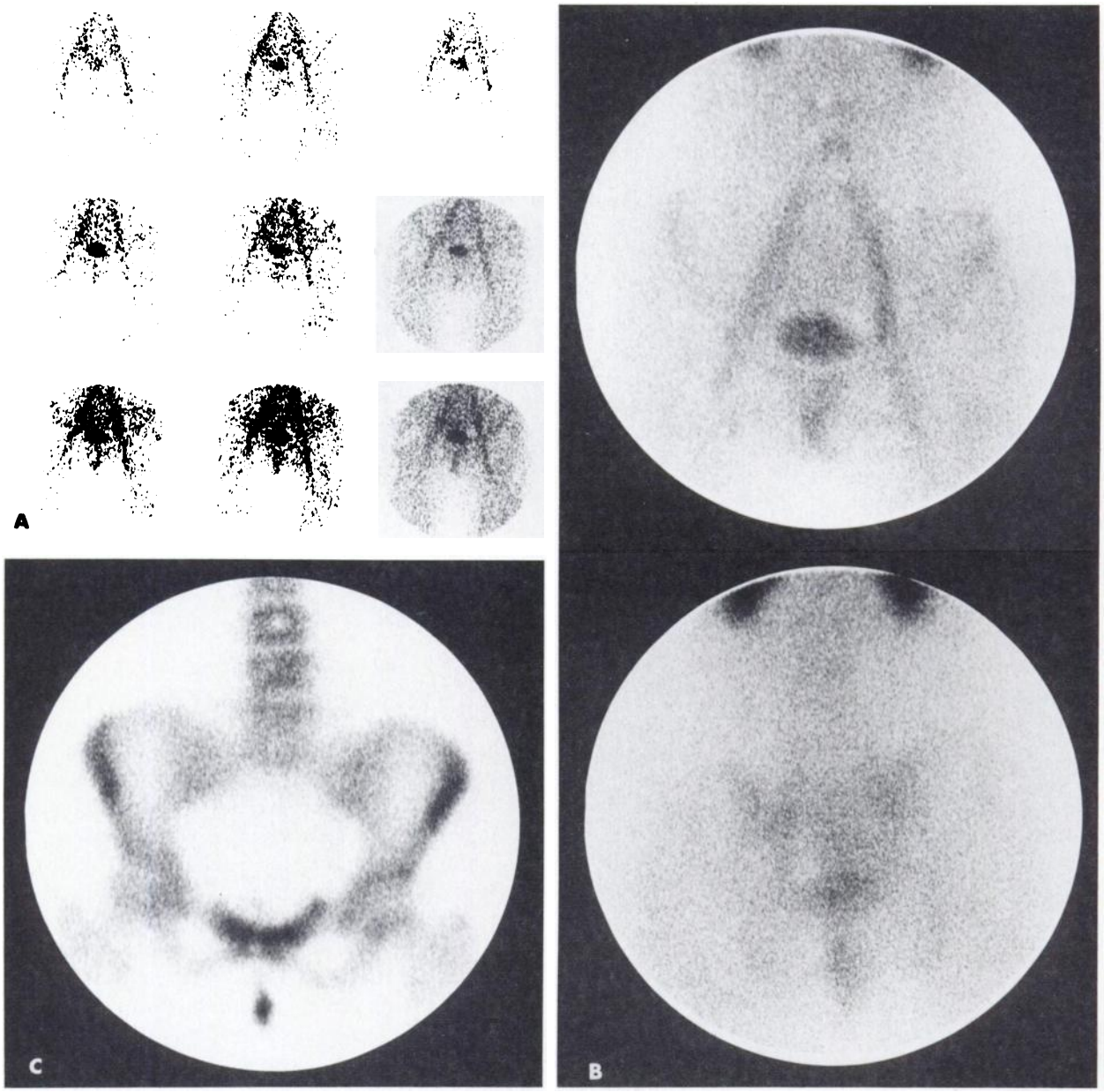

FIGURE 1
15-yr-old female in secretory phase of menstrual cycle. A: Anterior vascular images (5 sec/image) demonstrate intense supravesical accumulation of [^{99m}Tc]MDP. B: Anterior and posterior blood-pool images demonstrating uterine blush greater on anterior image than posterior image (probable anteverted uterus). C: Delayed anterior image shows disappearance of uterine activity

images. This is suggestive of a superficial focus of activity (perhaps cutaneous or subcutaneous). The other five premenarchial females did not demonstrate focal supravesical activity. All 29 postmenarchial females, whether in the menstrual phase (Days 1 to 4), proliferative phase (Days 4 to 12) or secretory phase (Days 12 to 28) of the menstrual cycle, demonstrated uterine uptake (see Table 1). There were 22 patients in the menstrual and secretory phases; 12 showed an intensity of uterine blush greater than that of the perineum. The other ten had uterine activity equal to perineal activity. Three of the seven patients in the proliferative phase had an intensity of uterine accumulation of the radiotracer in excess of the perineum. Two patients had less intense uterine activity and two had activity equal to that of the perineum. In patients with both anterior and posterior blood-pool images, uterine activity was more prominent on the anterior view except in two cases. In these two patients with greater uterine intensity on the posterior image, we hypothesized the presence of retroversion of the uterus. In one patient, confirmation was obtained by bimanual pelvic examination.

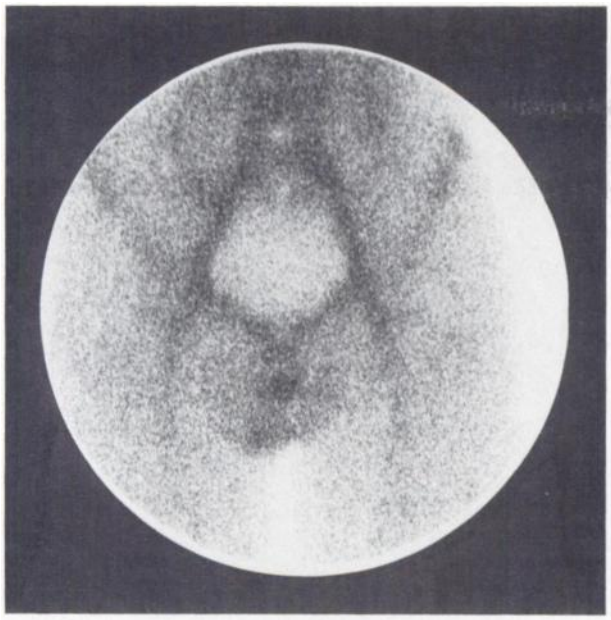

FIGURE 2
Anterior blood-pool image of control male subject with clear pelvic area

DISCUSSION

The appearance of the uterine blush occurred in all phases of the menstrual cycle in this study, contrary to a previous report (*2*) of uterine activity in Meckel's scanning which found that accumulation only in the menstrual and secretory phases of the menstrual cycle. To avoid misdiagnosis, those interpreting bone scintigrams should be aware of this physiologic concentration of bone-seeking tracer in the flow and blood-pool images.

The role of the three-phase bone scan (vascular, blood-pool, and delayed images) has been predominantly in the differentiation of osteomyelitis (increased activity on all phases) from cellulitis (increased activity limited to the first two phases) (*3*). In our institution, two-phase (blood-pool and delayed) and three-phase bone scans (vascular, blood-pool, and delayed) have been routinely utilized to evaluate patients who present with low-back and hip pain of undetermined etiology. The specificity of the three-phase study for osteomyelitis has been challenged by reports of increased triphasic uptake in tumors and acute fractures (*4*,*5*). The positive two- or three-phase scans in our population have been produced by osteoid osteoma, pseudoarthrosis, spondylolysis, and infection (discitis, osteomyelitis).

Uterine activity characteristically appears as a focal collection of activity in the midline below the bifurcation of the aorta on the flow images. It is first visualized after the iliac arteries fill. On the blood-pool images, uterine activity may be seen in both anterior and posterior views. Optimal visualization occurs before bladder filling. The uterus is just above the bladder, and the partially filled bladder may show an impression by the organ. As the bladder fills, however, the uterus becomes masked. The delayed images show fading of the activity and the organ is not visible. In these respects, the pattern of uterine visualization is similar to that noted on [^{99m}Tc]pertechnetate studies for Meckel's diverticulum. This pattern differs from heterotopic gastric mucosa which typically accumulates activity and gradually intensifies with time.

The uterine accumulation of tracer probably represents a combination of mechanisms such as hyperemia (secretory phase) and/or necrosis and hemorrhage (menses) (*2*). Other hyperemic foci such as inflammatory bowel disease, tumor, appendicitis, peptic intestinal ulcer, hemangioma, abscess, telangiectasia, feces in the cecum, and arteriovenous malformation might produce transient collections of increased activity on early bone scan images, as they have been reported to produce false-positive results on Meckel's scan (*6*). While there may be a number of conditions that require differentiation from uterine activity on early phase images, our observations indicate normal physiologic uptake is the most common.

Our study demonstrated the supravesical accumulation of activity in postmenarchial females on the blood-pool images in all three phases of the menstrual cycle (menstrual, proliferative, and secretory). This is in contrast with the report of Fink-Bennett (*2*) who did not observe uterine uptake of ^{99m}Tc in women who were in the proliferative phase. We found the degree of activity was relatively less intense (comparing uterus to the perineum) in two patients in the proliferative phase, but still present. The proliferative phase is known to be less hyperemic than the menstrual and secretory phases, but on our early phase images there was enough uterine perfusion to be recorded when the images were obtained with sufficient counts. The early proliferative endometrium is thin (<2 mm) but does contain numerous prominent blood vessels (*7*). There is a difference in scanning techniques between the blood-pool images on the Meckel's scans and on our bone scans that might explain the differing observations. The Meckel's scan is obtained as 1-min images following a dose of 150 μCi/kg (*2*). Our blood-pool images on the bone scan

TABLE 1
Intensity of Uterine Uptake*

Phase	Day	Less than perineum	Equal to perineum	Greater than perineum	Total
Menstrual	(1 to 4)	—	3	5	8
Proliferative	(4 to 12)	2	2	3	7
Secretory	(12 to 28)	—	7	7	14

* Pelvic blood-pool images of 29 postmenarchial females.

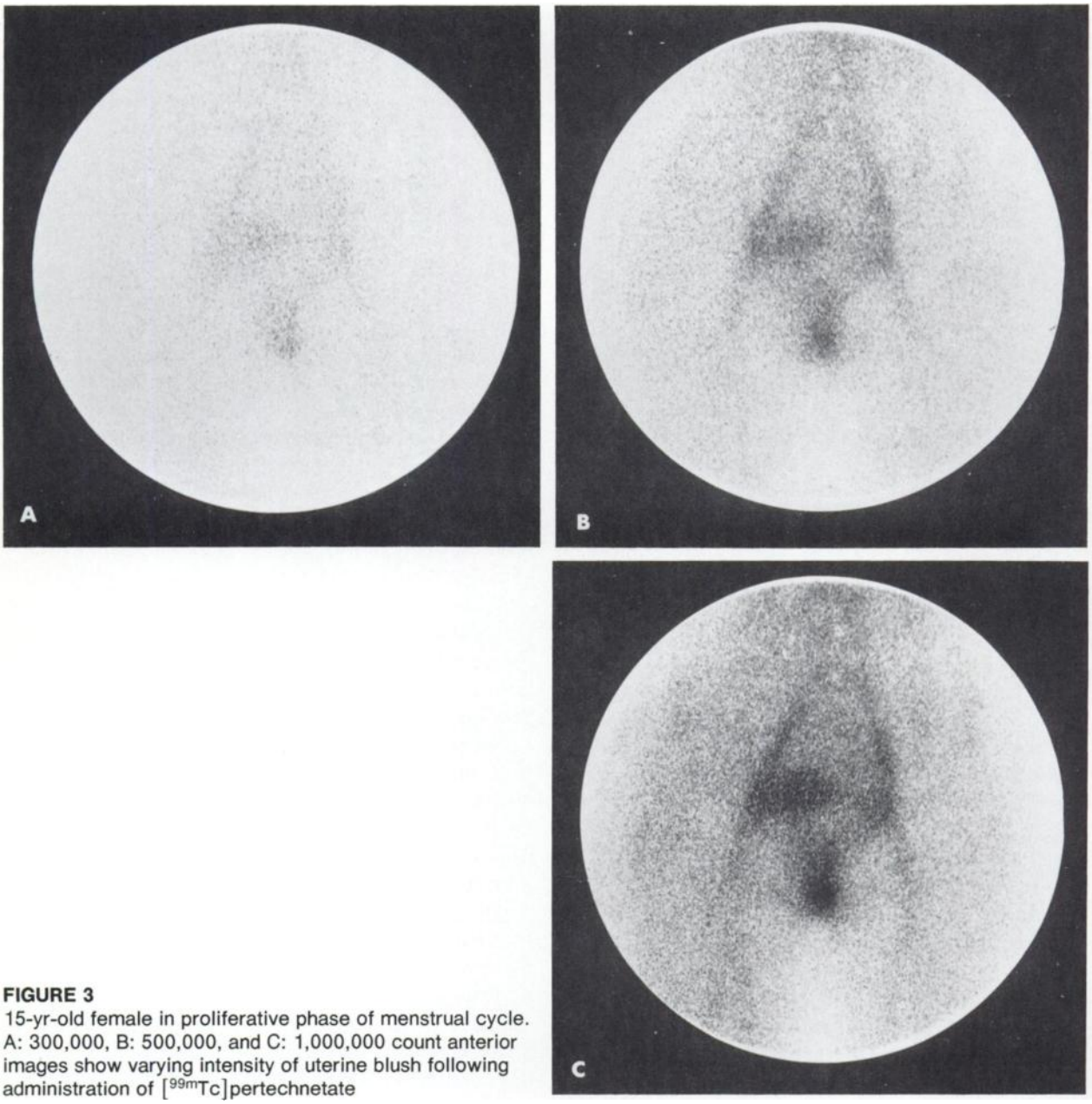

FIGURE 3
15-yr-old female in proliferative phase of menstrual cycle. A: 300,000, B: 500,000, and C: 1,000,000 count anterior images show varying intensity of uterine blush following administration of [^{99m}Tc]pertechnetate

follow a higher dose of 200 μCi/kg and consist of 500,000 to 1,000,000 count images. In order to simulate images obtained on a Meckel's scan, we obtained a series of pelvic images on a patient having a study with [^{99m}Tc]pertechnetate (200 μCi/kg) and utilized differing techniques. Three anterior pelvic views were obtained consecutively for: (a) 1 min (this yielded about 300,000 counts); (b) 500,000 counts; and (c) 1,000,000 counts to check for variation in intensity of the uterine blush. The greater statistics achieved from the blood-pool images of a bone scan theoretically would allow easier detection of smaller amounts of uterine activity. We, in fact, found that the uterine blush in this patient was seen more clearly on the highest count image (similar to our blood-pool image) than on the 1-min image (simulating a Meckel's image). This patient incidentally was in the proliferative phase of her cycle.

In conclusion, the presence of uterine blush on the flow and blood-pool images of the triphasic bone scan can be recognized in postmenarchial females in all phases of the menstrual cycle. When interpreting scintigrams of such patients, one should recognize this as a normal transient physiologic phenomenon, not to be mistaken for pelvic pathology.

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