Enlargement of the spleen as an incidental finding on CT in post-partum females with fever

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Objective: The aim was to evaluate whether enlargement of the spleen on CT in a post-partum female with fever is a common phenomenon.

Methods: In this retrospective institutional review board-approved study, the spleen was measured by CT in 77 females (average age 30.7 years) examined for post-partum fever and a control group of 58 febrile females imaged for suspected appendicitis (average age 29.7 years). The splenic length, width and thickness were measured and used to calculate the splenic index. The measurements of both groups of patients were compared. The size of the spleen was assessed again in 12 of the 77 post-partum female who had a follow-up CT for unrelated reasons. Continuous variables were compared, by groups, using analysis of variance (ANOVA). ANOVA with repeated measures was used to evaluate changes over time. A p -value <0.05 was considered significant.

Results: The length, thickness and width of the spleen were significantly larger in the patients imaged after delivery compared with those in the control group ($p < 0.001$ for all three comparisons). The mean splenic index was 686.6 cm^3 in the post-partum group and 408.1 cm^3 in the control group ($p < 0.001$). The splenic dimensions and index were significantly smaller in the 12 post-partum females who had a follow-up study.

Conclusion: An enlarged spleen in febrile females undergoing CT in the puerperium may reflect physiological changes occurring during pregnancy.

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There is very little information in the radiological or medical literature regarding the changes that occur in the spleen throughout pregnancy or in the post-partum period. In a recent article, the findings on ultrasonography showed significant overall growth of the spleen during pregnancy [1]. Ultrasound is the imaging technique of choice in pregnant patients. In contrast, CT is only rarely performed during pregnancy; therefore, splenic enlargement during pregnancy is rarely encountered by radiologists interpreting CT and they may not be aware of this phenomenon. If an enlarged spleen is seen when CT is performed in the post-partum period for fever of unknown origin, this could be a reason for concern.

Splenomegaly may indicate a wide range of pathological processes, necessitating additional work-up. However, if the splenic enlargement is the only abnormal finding on CT and clinical recovery is complete, the enlarged spleen may reflect physiological changes that have occurred during pregnancy and should not raise undue concern.

We investigated whether splenomegaly observed in pregnant patients on ultrasound is also seen on CT after delivery, when CT is performed for post-partum fever.

Methods and materials

This retrospective study was approved by our institutional review board.

All consecutive patients with puerperal fever referred for abdominal CT during a 5-year period (from 1 January 2005 to 31 December 2009) were included in the study. Their medical records were evaluated for any pre-existing disease, specifically for any disease that might cause splenic enlargement.

Patient's age and the time interval (number of days) between delivery and CT study were recorded.

All CT studies were performed with a 16-slice or 64-slice scanner (MX 8000 IDT 16 and Brilliance 64; Philips, Haifa, Israel). Scans were evaluated on a picture archiving and communication system (PACS) system (Philips).

The CT scans were acquired after intravenous contrast administration (Ultravist 300, Iopromide 300 mg I/ml; Schering AG, Berlin, Germany) during the portal venous phase, 70 s after the start of injection.

The width, thickness and craniocaudal length of the spleen were recorded and used to calculate the splenic index [2–5]. Width was measured as the greatest antero-posterior dimension at the hilum. Thickness was measured at the level of the splenic hilum between the inner and outer borders of the spleen. Two or three measurements were averaged when the thickness of the anterior and posterior portions of the spleen differed considerably. These two measurements were made on axial images (Figure 1). Maximum craniocaudal length was measured from the most superior margin to the most inferior one on the coronal reformat.

The normal spleen measures approximately 12 cm in length, 7 cm in an anteroposterior diameter and 4 cm in thickness, and the normal splenic size corresponds to an index of $120\text{--}480 \text{ cm}^3$ [2–5].

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Figure 1. (a) Images from a 34-year-old female with fever and abdominal pain 6 days after vaginal delivery. Axial contrast-enhanced CT at the level of the splenic hilum: the splenic width measures 12.5 cm and the thickness 3.7 cm. The length measured 13 cm, and the splenic index was 601 cm³. (b) Axial contrast-enhanced CT at the same level 6 months later (performed for evaluation of unclear pulmonary findings on a chest radiograph). The splenic width now measures 11.1 cm and the thickness measures 3.4 cm. The length measures 12 cm (not shown), and the splenic index is 453 cm³.

We reviewed all additional studies in the patients who underwent a follow-up CT and were not pregnant at that time. We recorded the time interval between the two studies and compared the measurements of splenic size in both studies.

The control group included 58 females, who had not recently given birth, who underwent CT during the same period of time for evaluation of fever and clinical suspicion of appendicitis. Their ages were similar to those of the post-partum group.

Measurements of the spleen were obtained with electronic callipers by two abdominal radiologists (GG and ABE) with 19 and 3 years' experience, respectively. They agreed on the results for each measurement and were blinded to patients' information. The splenic parenchyma was also evaluated and was rated as homogeneous or inhomogeneous on both abdominal and narrow window settings (level 50 HU, width 350 HU; level 80 HU, width 180 HU, respectively). Pathological CT findings, when present, were noted.

Statistical analysis

The data were analysed using BMDP [6]. Continuous variables were compared by groups using analysis of

variance (ANOVA). ANOVA with repeated measures was used to evaluate changes over time. A *p*-value <0.05 was considered significant.

Results

79 consecutive puerperal females were referred to CT for evaluation of fever. None of the patients had a known pre-existing medical condition that might result in enlargement of the spleen. However, 2 patients with a markedly enlarged and heterogeneous spleen were subsequently diagnosed with lymphoma and were therefore excluded from the study, leaving 77 females in the post-partum group. We initially divided the patients into two groups: post-vaginal delivery (*n*=21) and post-Caesarean delivery (*n*=56). We compared the following parameters in both groups: age, interval between delivery and CT study, and splenic measurements (length, thickness, width and splenic index) (Table 1). No statistically significant difference was noted between any of these parameters in the two groups and they were combined into one group of post-partum patients. The age ranged from 17 to 43 years with an average of 30.9 years. CT study was performed between 1 and 36 days after delivery with an average of 7 days. The splenic parenchyma was homogeneous in all studies.

Table 1. Characteristics of 77 post-partum females undergoing CT following Caesarean (*n*=56) or vaginal delivery (*n*=21)

Patients' data and spleen size measurements	Caesarean delivery (<i>n</i> =56)	Vaginal delivery (<i>n</i> =21)	Significance of difference (<i>p</i> -value)
Age (years)	30.9 ± 5.7 (16.8–43.3)	30.2 ± 6.0 (18–43.9)	0.65
Interval delivery—CT (days)	7.7 ± 3.5 (1–18)	7.3 ± 7.8 (1–38)	0.78
Spleen length (cm)	11.2 ± 2.1 (7.3–18.0)	11.2 ± 1.2 (8.5–13.0)	0.95
Spleen thickness (cm)	5.0 ± 0.8 (3.4–6.5)	5.0 ± 0.7 (3.2–6.5)	0.86
Spleen width (cm)	12.0 ± 2.0 (7.3–16.0)	12.2 ± 2.0 (8.4–15.5)	0.70
Splenic index	686.2 ± 260.5 (242.4–1287.9)	687.8 ± 184.6 (266.6–1014.0)	0.98

Data are mean values ± standard deviations. Numbers in parentheses are ranges.

Table 2. Characteristics of 77 post-partum females compared with 58 females evaluated for appendicitis

Patients' data and spleen size measurements	Post partum (n=77)	Appendicitis (n=58)	Significance of difference (p-value)
Age (years)	30.7 ± 5.7 (17–43)	29.7 ± 6.5 (17–43)	0.35
Spleen length (cm)	11.2 ± 1.9 (7.3–18.0)	9.6 ± 1.6 (6.0–15.6)	<0.001
Spleen thickness (cm)	5.0 ± 0.8 (3.2–6.5)	4.0 ± 0.6 (2.7–5.2)	<0.001
Spleen width (cm)	12.0 ± 2.0 (7.3–16.0)	10.6 ± 1.6 (7.5–14.0)	<0.001
Splenic index	686.6 ± 241.0 (242.4–1287.9)	408.1 ± 122.8 (177.1– 748.0)	<0.001

Data are mean values ± standard deviations. Numbers in parentheses are ranges.

Identical parameters were recorded in the control group of 58 febrile females undergoing CT for evaluation of appendicitis who subsequently underwent appendectomy. Table 2 summarises the results of the two groups. There was no statistically significant difference in the ages of the patients in both groups. The mean length of the spleen in the post-partum group was 11.2 cm compared with 9.6 cm in the control group. The mean thickness was 5.0 cm compared with 4.0 cm for the control group and the mean width was 12.0 cm compared with 10.6 cm for the control group (Figures 1 and 2). There was a highly statistically significant difference ($p < 0.001$) in each of the measurements of the spleen: the length, thickness and width, and in the splenic index. The mean splenic index in the post-partum group was approximately 68% larger than in the control group (686.6 cm³ compared with 408.1 cm³). 62 of the 77 (81%) post-partum females had a splenic index exceeding 480 cm³ compared with only 8 of the 58 (14%) females in the control group.

12 patients in the post-partum group had a follow-up CT study between 1 week and 26 months (average 7 months) after the initial CT for various abdominal symptoms. None of the patients had developed a condition known to affect the spleen. Comparison between the two studies revealed a statistically significant decrease in splenic size (Table 3) (Figure 1a,b).

The CT findings of the 77 post-partum females showed that there was a marked difference in the frequency of pathological findings in those after Caesarean delivery compared with those after vaginal delivery. In 47 of the 56 (84%) patients the CT scan after Caesarean delivery was abnormal, compared with only 8 of 21 (38%) females after vaginal delivery. Abnormal findings that could account for fever in the post-partum females with both types of delivery are summarised in Table 4.

Discussion

The mean splenic index was approximately 68% larger in the recent delivery group than in the control group with appendicitis. This difference in splenic size was highly significant ($p < 0.001$).

The patients in the post-partum group underwent CT owing to fever after delivery in order to identify a possible source of infection. Findings that could explain the fever were present in the majority of patients after Caesarean section and in approximately one-third of the patients after vaginal delivery. None of these findings were associated with splenomegaly, and none of the patients had any evidence of infection, such as endocarditis, acquired immune deficiency syndrome, haematological disease or other conditions that could account for the splenomegaly [7–10].

Figure 2. (a) Images from a 22-year-old female with fever and abdominal pain 6 days after Caesarean section. Axial contrast-enhanced CT at the level of the splenic hilum: the splenic width measures 15.2 cm and the thickness 5.3 cm. (b) Craniocaudal length of the spleen measured on the coronal reformat is 14.6 cm. The splenic index is 1176 cm³. The enlarged post-partum uterus is seen on this reformat. B, bladder; U, uterus.

Table 3. Change in spleen size between post-partum CT and follow-up CT in 12 females

Spleen size measurement	First CT	Second CT	Significance of difference (p-value)
Length (cm)	11.3 ± 1.3	10.5 ± 1.1	0.043
Thickness (cm)	5.1 ± 0.7	4.5 ± 0.7	0.039
Width (cm)	12.9 ± 1.7	12.1 ± 1.3	0.008
Splenic index	744.4 ± 165.1	577.2 ± 151.2	0.018

Data are mean values ± standard deviations.

Table 4. CT findings likely to account for fever in the 77 post-partum females

Type of delivery/CT findings	Caesarean delivery (n=56)	Vaginal delivery (n=21)	Total (n=77)
Positive CT findings^a	47	8	55
Fluid collections	40		17
Abdominal wall scar only	17		
Pelvis only	13		13
Abdominal wall scar and pelvis	7		7
Intra-uterine fluid and air	2	1	3
Small bowel obstruction	3		3
Ovarian vein thrombosis	2	3	5
Pyelonephritis	1	3	4
Bile duct dilatation	1		1
Free pelvic fluid	1	2	3
Normal CT	9	13	22

^aSeveral patients had more than one finding.

Enlargement of the spleen is associated with several abnormal conditions, such as haematological disorders, infectious diseases, hepatic diseases and storage diseases, in order of decreasing incidence [7–10]. Therefore, if an enlarged spleen is detected in an otherwise healthy patient, this finding might initiate a systematic work-up, which could be costly, time consuming and worrying for the patient. Consequently, it is important to try to establish whether an increase in the size of the spleen is common after delivery. If so, it may reflect merely a reversible physiological change occurring during pregnancy.

The follow-up CT scans in 12 of the females in the post-partum group showed a statistically significant decrease in their mean splenic size. This suggests that splenomegaly detected after childbirth may be related to temporary physiological changes of recent pregnancy.

There is very little information in the radiological or medical literature describing changes occurring to the spleen throughout pregnancy in humans.

In a recent study, we evaluated the size of the spleen on ultrasonography throughout pregnancy and found a significant overall growth pattern of spleen area with increasing gestational age [1]. In the current study, based on CT, post-partum splenomegaly concurs with the previously recorded gradual increase in size of the spleen during pregnancy found on ultrasound [1]. Although we could find no other studies in humans, splenomegaly has been documented in pregnant rats with up to a 50% increase in weight [11, 12]. These maternal rat spleens regress post partum to their non-pregnant weight [11].

The cause of splenomegaly in pregnancy is not known. A possible explanation might be related to the cardiovascular and haemodynamic changes that occur during pregnancy [13]. Blood volume increases gradually over the gestation period, reaching a 40% increase by term [13]. More than a 60% increase in splanchnic blood flow

starts early in pregnancy and peaks at the end of the second trimester [14].

There are some limitations to our study. Only post-partum females with fever were referred for CT. Ideally, the post-partum group (or alternatively, the control group) would include post-partum females without fever, but there is usually no other indication for CT in these patients. Another limitation is that we could not find similar studies in the literature for comparison.

Conclusion

Mild and even moderate splenomegaly observed in females undergoing CT shortly after delivery is probably a normal finding that reflects physiological changes related to recent pregnancy. Further studies are needed to investigate the association between splenomegaly and pregnancy and to establish how long after delivery splenomegaly persists.

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