

# Postsplenectomy Splenic Activity

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Evidence of recurring activity of splenic tissue was investigated in patients who had undergone splenectomies. Methods included technetium 99m sulfur colloid scan, serum tuftsin assay, serum immunoglobulin concentration, blood cell counts, and search for Howell-Jolly bodies. Positive scans were observed together with normal levels of tuftsin in 54% of the patients. In 46% of the patients, no splenic activity was detected by scanning and low levels of tuftsin were noticed. The difference in tuftsin levels between the two groups was statistically significant. Howell-Jolly bodies and decreased serum levels of IgM featured all patients. The possible application of combined splenic scan and tuftsin assessment for screening recurring splenic activity in the postsplenectomy population at great risk is suggested.

**G**ALEN'S APPRAISAL OF THE SPLEEN as a misterii pleni organon (an organ full of mystery) continues to be appropriate despite the passage of time and the advances in Medicine. Since Maimonides, in the twelfth century, emphasized the blood purifying properties of the spleen,<sup>1</sup> differing opinions as to the exact role of this organ have been expressed. During the last decades splenectomy has been widely used as the treatment of choice for both trauma and hematologic disorders. This approach, termed by Morgenstern<sup>2</sup> "the surgical inviolability of the spleen" has been challenged by numerous publications confirming King and Schumacker's report<sup>3</sup> on the increased susceptibility to infection in splenectomized infants. Overwhelming sepsis has also been reported in adults,<sup>4,5</sup> even many years after splenectomy.<sup>6</sup>

The incidence of sepsis after removal of spleen for trauma (0.5–1%) is considerably lower than that following splenectomy for other causes (1–25%).<sup>7</sup> Normal levels of tuftsin, a physiologic phagocytosis-stimulating peptide,<sup>8</sup> were found by Constantopoulos and Najjar<sup>9</sup> in three patients after splenectomy for trauma. Whereas tuftsin deficiency was characteristic of patients who underwent splenectomy for other reasons. Pearson,<sup>10</sup> using Tc 99m sulfur colloid scan, showed splenic tissue

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activity in five children who had previously had their spleens removed because of injury. Both findings—normal tuftsin levels and evidence of recurring splenic function after traumatic splenectomy—although to date studied separately and reported in a very small number of cases, may account for the low incidence of overwhelming sepsis in these patients.

The results of a search for splenic activity in a series of patients who underwent splenectomy, by assessing for the first time serum tuftsin levels together with splenic scanning are reported. Blood cell counts, Howell-Jolly bodies and serum immunoglobulin levels were also investigated.

## Materials and Methods

Seventy-two patients underwent splenectomies between 1968 and 1979. Twenty-six patients met the criteria for inclusion in the study, namely, availability of complete follow-up data and consent of the patient to participate in the research. There were 19 men and 7 women, ranging in age from 6.5 to 71 years. Splenectomy had been performed because of trauma in 12 of the patients, incidentally during vagotomy or gastric resection in ten, electively for hematologic disorders in three and because giant splenic cyst in one. The follow-up study performed included clinical history, physical examination, radioimmunoassay for serum tuftsin,<sup>11</sup> splenic scan with Tc 99m sulfur colloid, hematologic studies (blood cell counts, Howell-Jolly bodies), and serum immunoglobulin levels by radial immunodiffusion.<sup>12</sup>

## Results

The 26 patients were classified into two groups according to the presence (group 1) or absence (group 2)

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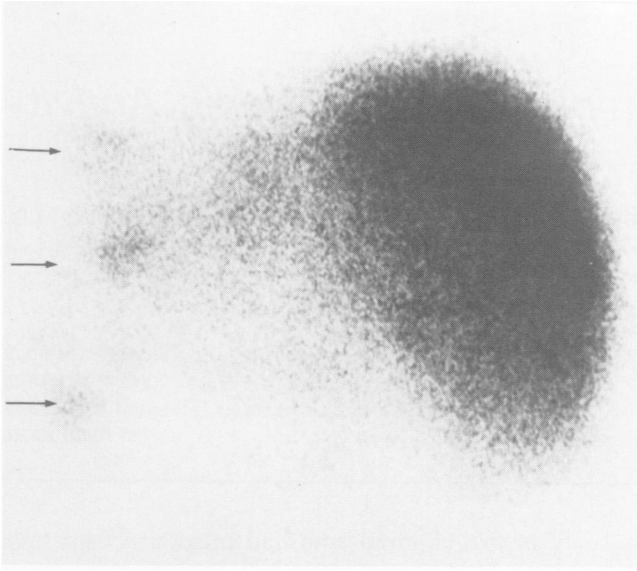


FIG. 1. Tc 99m splenic scan (posterior view) in a patient after splenectomy because of trauma. Three nodules of splenic activity are indicated by the arrows.

of splenic tissue activity on the splenic scan (Figs. 1 and 2). Group 1 included 14 (54%) of the patients: eight patients (57%) who underwent splenectomies for trauma, five (36%) who underwent incidental splenectomies, and one (7%) who underwent elective resection for hematologic disease. Group 2 comprised 12 patients (46%):

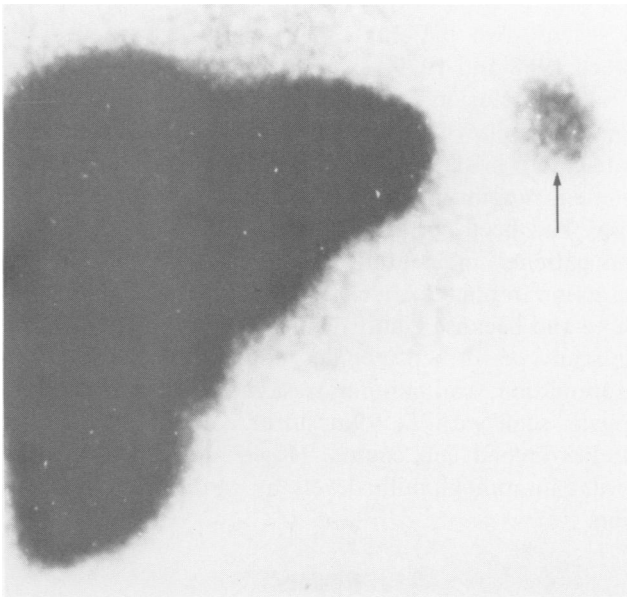


FIG. 2. Tc 99m splenic scan (anterior view) in a patient after splenectomy due to trauma. A nodule of splenic activity, indicated by the arrow, is present in the left upper quadrant.

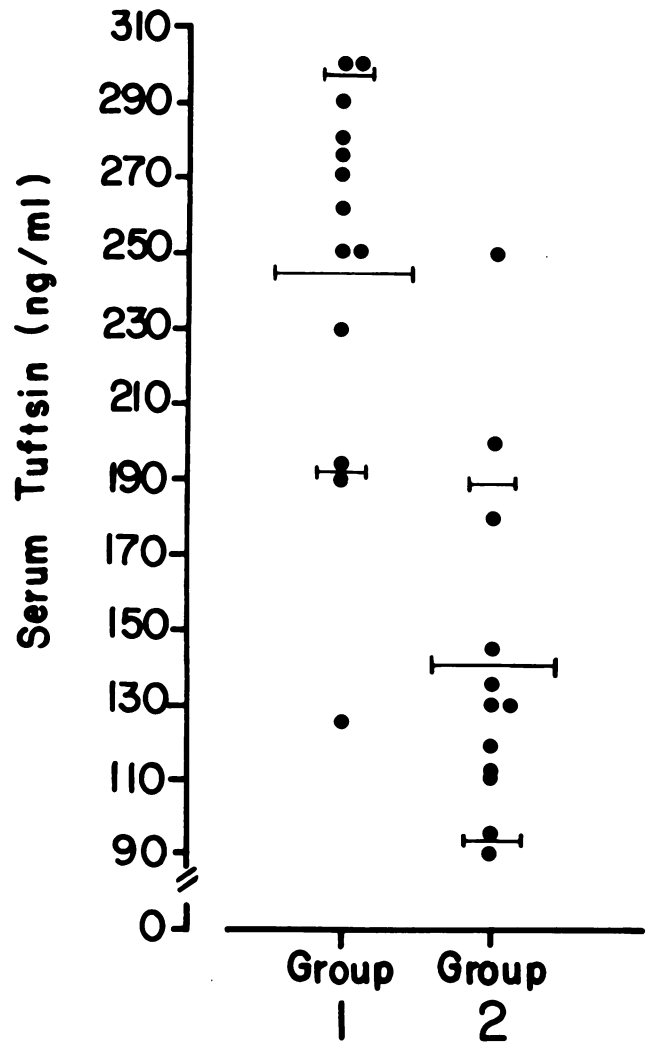


FIG. 3. Serum concentrations of tuftsin in patients with positive (group 1) and negative (group 2) Tc 99m splenic scan.

4 (33%) after splenectomies because of trauma, 5 (42%) after incidental splenectomies, and 3 (25%) who underwent elective splenectomies for hematologic disorders.

There were no records of severe infections in any of the patients during the postoperative period; small bowel obstructions occurred in three patients of group 1.

Tuftsin serum levels (Fig. 3) in patients of group 1 ranged from 125 to 300 ng/ml, mean:  $246 \pm 52$  ng/ml (Normal levels:  $228.7 \pm 46.7$  ng/ml).<sup>11</sup> In group 2, levels ranged from 90 to 250 ng/ml, mean:  $141 \pm 47$  ng/ml. The difference in tuftsin levels between the two groups was statistically significant ( $p < 0.001$ ).

Blood cell counts were within normal limits in all cases. Thrombocytes over 400,000 per  $\text{mm}^3$  were present in ten patients in group 1 and in seven in group 2. With the exception of one patient in group 2, giant

thrombocytes were found in all cases. Howell-Jolly bodies characterized all patients of both groups.

IgA and IgG serum levels were within normal ranges in both groups. IgM in group 1 ( $99.5 \pm 89.7$ ) and in group 2 ( $121.7 \pm 90.4$ ) was significantly reduced when compared with normal values ( $235 \pm 92.0$ ):  $p < 0.01$ .

### Discussion

Normal tuftsin levels characterized almost all patients in whom scans showed splenic tissue activity; trauma was the most common cause of splenectomy in this group. On the other hand, low levels of tuftsin and negative scans were found in group 2. Tuftsin is a tetrapeptide discovered and isolated at Tufts University.<sup>8</sup> Defective phagocytosis due to tuftsin deficiency has been reported in patients after splenectomies<sup>9</sup> or with recurring infections.<sup>13</sup> Martinez demonstrated a protective effect of tuftsin against pneumococcal challenge in mice.<sup>14</sup>

The recurring splenic tissue activity in the patients who underwent splenectomies may be due to splenosis and/or accessory spleens. Splenosis is the term introduced by Buchbinder and Lipkoff,<sup>15</sup> in 1939, to describe the condition of multiple peritoneal implants of splenic tissue after severe trauma to the spleen. Disruption of the splenic capsule causes fragments of splenic pulp to be seeded throughout the peritoneal cavity, their number varying from several to 400 or more. The auto-transplanted nodules are reddish-blue, usually sessile, and are found most often in the following locations: serosal surface of small bowel, greater omentum, parietal peritoneum, serosal surface of colon, mesentery and under the surface of the diaphragm. Blood supply is provided by small new arteries penetrating the capsule, which is derived from surrounding reactive granulation and fibrous tissue.<sup>16</sup>

Accessory spleens are usually few in number, are generally located near the hilus of the main spleen, and correspond to the embryologic development of the spleen to the left side of the dorsal mesogastrium. They differ from splenosis in that they are like miniatures of the main spleen, and receive their blood supply via a small branch of the splenic artery. They have a real capsule containing smooth muscle and elastic tissue components, all of which are absent in splenosis.

Previous reports<sup>10</sup> have attributed positive splenic scans exclusively to splenosis. However, accessory spleens, found in 10–44% of the patients who underwent autopsy examinations<sup>16</sup> may account for splenic function in some patients, and it appears that only laparotomy or postmortem examination can ascertain the exact cause of splenic activity.

Howell-Jolly bodies were present in all our patients who underwent splenectomies. While generally considered evidence of asplenia, they have been found also in patients with splenosis.<sup>16</sup> Pearson<sup>10</sup> considers their presence a subtle morphologic finding, but states that quantitative assessment of degrees of splenic activity cannot be made on the basis of their number. Splenic scan is considered a more sensitive indicator of splenic tissue activity than blood studies.<sup>17</sup>

Our findings of normal IgA and IgG serum levels and decreased IgM values after splenectomy are similar to those reported by Schumacher.<sup>18</sup>

Is the evidence of returning splenic function an expression of reacquired resistance to infection? Overwhelming sepsis has been reported in patients who underwent splenectomies with splenosis or remaining accessory spleens,<sup>5,19</sup> although with low incidence, and in all these cases, a very small amount of splenic tissue was found. Experimental animal studies and clinical observations<sup>20</sup> suggest that at least two factors are important to protect against infection—the volume of splenic tissue and the presence of normal blood supply. The minimal amount of residual splenic tissue that is necessary for this purpose is still unknown. It has been estimated by Singer<sup>19</sup> by deductive reasoning to be about 25–30 g. No evidence of severe postsplenectomy sepsis was found in our study, but the postoperative period we investigated was relatively short. Overwhelming sepsis has been described even many years after splenectomy.

Further experimental and prospective clinical studies are needed to determine the precise value of tuftsin and splenic scan for screening the postsplenectomy population at great risk.

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