ACUTE RENAL CARBUNCLE*

THE ROENTGENOGRAPHIC CLARIFICATION OF A MEDICAL ENIGMA

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Most roentgenographic descriptions of renal carbuncle emphasize the features, depicting mainly the subacute and chronic varieties. Although the diagnostic criteria for renal carbuncle have improved, the over-all diagnostic accuracy prior to surgery is still poor and rarely extends beyond 20 per cent in most series. An even greater diagnostic challenge is the acute renal carbuncle. This at one time was almost never accurately diagnosed. Nevertheless, this form of renal infection is by no means uncommon or insignificant, and with the problem of increasing drug addiction by "mainlining" is becoming more frequent. The diagnosis may be clinically suspected when symptoms of fever, chills, and pain localized to the flank, or the signs of sepsis are present. More often, however, symptoms related to the urinary tract are absent, and the urinalysis is practically always normal or nondiagnostic. In addition, if one waits for gross urographic changes to occur before making the diagnosis, much valuable time will be lost. Evans et al., and Himmelfarb et al., in their descriptions of renal carbuncle, alluded to many roentgenographic findings observed in the acute phase. Precise analysis of these findings and their relation to an exact diagnosis were not stressed.

The purpose of this paper is to further analyze the major roentgenographic findings of acute renal carbuncle, so that accurate and definitive criteria can be established.

CASE MATERIAL

A total of 6 patients are presented in this paper (Table 1). Their ages range from 14 to 60 years. Surprisingly, there appears to be an equal distribution of sex, with 3 females and 3 males. Two of the men were in the older age group and the primary disease was related to the prostate gland. In both, the involved organism was E. coli. In the remaining 4 cases, the causative agent was Staphylococcus aureus. The 3 females were in their twenties and all were drug addicts. Furunculosis was the initial focus of infection in the remaining male patient.

PATHOLOGY

Since the roentgenographic pattern is a reflection of the underlying pathologic changes, a brief review is in order.

Acute infection of the kidney, in general, arises either on a hematogenous basis or via a cysto-ureteric route. Staphylococcus aureus is the most common bloodborn organism and E. coli the causative agent in ascending infections.

The definition of an acute carbuncle is an area of severe supplicative pyelonephritis containing many micro-abscesses coalescing into larger confluent abscesses with as yet not well defined walls. Originally, multiple small abscesses of varying size are formed within the cortex from either septic emboli lodged within the smaller vessels or by lymphatic extension from a supplicative pyelonephritis arising within the medulla. Cortical involvement stimulates a pronounced inflammatory response primarily because of the large blood supply feeding the cortex, and secondarily because of the lower levels of interstitial pressure. The latter enables the cells to move easily into the inflammatory area. The process may be diffuse, virtually involving the entire

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kidney, or remain limited to only a portion or portions of the kidney. It is basically parenchymal in location and does not communicate with the collecting system in its early form. Extension through the capsule into the perirenal tissues is nevertheless almost always present, and at one time was thought to be the primary site of involvement. It is now believed that perirenal infection arises secondarily from lesions within the renal cortex via the peripheral lymphatics.

ROENTGENOGRAPHIC FEATURES

The roentgenographic features described represent the composite findings of the 6 patients presented and some personal observations noted in other patients. In general, the entire spectrum of the roentgenographic features prior to angiographic studies consists of a combination of changes indicating both the presence of interstitial or parenchymal disease with associated perirenal involvement.

A. FLAT FILM ROENTGENOGRAPHY OF THE ABDOMEN

With the kidney either diffusely or partially involved by the inflammatory process, a supine roentgenogram of the abdomen demonstrates either diffuse or local enlargement of the renal shadow. Simultaneously occurring perirenal disease is common and, when present, obscures the renal and the psoas muscle shadows (Fig. 1). In 2 of our cases, pronounced perirenal involvement was present, causing an increased density within the retroperitoneum as well as associated scoliosis. In 1 patient, the diseased kidney was also fixed during respiration (Fig. 2). Further extension of the pro-

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### Table I

SUMMARY OF FINDINGS IN 6 CASES

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Sex</th>
<th>Drug Addict</th>
<th>Age (yr.)</th>
<th>Plain Roentgenograms</th>
<th>Intravenous Pyelograms</th>
<th>Arteriograms</th>
<th>Comments</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>M</td>
<td>no</td>
<td>14</td>
<td>questionable changes</td>
<td>1. partial visualization 2. mass effect</td>
<td>--</td>
<td>--</td>
<td>furunculosis</td>
</tr>
<tr>
<td>II</td>
<td>F</td>
<td>yes</td>
<td>24</td>
<td>mass of left kidney</td>
<td>nonvisualization</td>
<td>1. displacement of calyces 2. mass</td>
<td>a, b, c.</td>
<td>1. surgical removal 2. carbuncle of upper pole</td>
</tr>
<tr>
<td>III</td>
<td>F</td>
<td>yes</td>
<td>28</td>
<td>mass of right kidney</td>
<td>poor visualization</td>
<td>--</td>
<td>refused</td>
<td>1. lost to follow-up</td>
</tr>
<tr>
<td>IV</td>
<td>F</td>
<td>yes</td>
<td>20</td>
<td>mass of left kidney</td>
<td>partial to poor visualization</td>
<td>--</td>
<td>a, b, c.</td>
<td>1. drainage 2. clinically improved 3. intravenous pyelogram—normal</td>
</tr>
<tr>
<td>V</td>
<td>M</td>
<td>no</td>
<td>55</td>
<td>no mass</td>
<td>nonvisualization</td>
<td>--</td>
<td>questionable a, b, c.</td>
<td>prosatic carcinoma</td>
</tr>
<tr>
<td>VI</td>
<td>M</td>
<td>no</td>
<td>62</td>
<td>not available</td>
<td>nonvisualization</td>
<td>1. dilated calyces 2. no displacement 3. filling defect in ureter</td>
<td>a, b, c.</td>
<td>1. surgical removal 2. diffuse involvement</td>
</tr>
</tbody>
</table>

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completely nonvisualized, this procedure may be necessary to exclude the presence of either ureteral obstruction by calculus or pyonephrosis. Although the clinical presentation of both these latter entities resembles that observed in acute carbuncle, the therapeutic approach is quite different. Differentiation is therefore very important. In 1 patient with a nonvisualized collecting system, no evidence of obstruction was demonstrated by retrograde pyelography. The calyces were well outlined and displaced downward by a large mass in the upper pole (Fig. 4). In another patient, ureteral obstruction caused by tissue slough within the ureter was demonstrated and a specific diagnosis in this case could not be accomplished. Following surgical removal, the kidney demonstrated diffuse parenchymal disease and necrosis.

D. NEPHROTOMOGRAPHY

Nephrotomography was not performed on any of our patients. However, in our institution, as well as in others, tomography is now being utilized almost routinely in conjunction with high dose pyelography, and is once again becoming an important diagnostic procedure. In patients showing some degree of visualization, it may prove worthwhile to eliminate the need for arteriography, speed the diagnostic time, and

B. INTRAVENOUS PYELOGRAPHY

The findings encountered on intravenous pyelography vary from partial to poor, to complete nonvisualization of the collecting systems (Fig. 3, A–C). Partial visualization was observed in 50 per cent of patients. Specific calyceal changes can be noted in the locally infected area. The calyces were either poorly opacified or amputated in contrast to the remaining fairly adequately visualized collecting systems. In some cases, the affected calyces were stretched and draped around a suggested localized mass.

C. RETROGRADE PYELOGRAPHY

The need for retrograde pyelography in the diagnosis of acute renal carbuncle is limited. Most of the necessary information can be derived from intravenous pyelography and nephrotomography. However, in cases where the collecting systems are completely nonvisualized, this procedure may be necessary to exclude the presence of either ureteral obstruction by calculus or pyonephrosis. Although the clinical presentation of both these latter entities resembles that observed in acute carbuncle, the therapeutic approach is quite different. Differentiation is therefore very important. In 1 patient with a nonvisualized collecting system, no evidence of obstruction was demonstrated by retrograde pyelography. The calyces were well outlined and displaced downward by a large mass in the upper pole (Fig. 4). In another patient, ureteral obstruction caused by tissue slough within the ureter was demonstrated and a specific diagnosis in this case could not be accomplished. Following surgical removal, the kidney demonstrated diffuse parenchymal disease and necrosis.

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Fig. 3. (A) Intravenous pyelogram reveals enlargement of the upper pole of the right kidney. Most of the calyces are well visualized except for the upper pole calyx which appears amputated. There is also suggested depression of the remaining calyceal structures by an upper pole mass. (B) The right kidney is diffusely enlarged with the upper pole more prominent than normal. Most of the calyces are poorly visualized and spread apart. These changes indicate a diffuse process, although a more localized process in the upper pole is suggested. (C) Intravenous pyelogram in this patient revealed a fairly well functioning right kidney. On the left, there is no visualization. Instead, one notes a suggested mass within the upper pole.
The study reveals moderate dilatation of the calyceal structures, which are displaced downward by a mass within the upper pole (arrows).
Fig. 6. (A) Arteriogram. This patient had a suggested mass in the upper pole of the left kidney (Fig. 3C; and 5). However, on the arteriographic studies, the vessels are not remarkably displaced. Instead, there is only vague separation of the vessels, which also appear to be somewhat poorly opacified. The margin of the upper pole is also fuzzy and unsharp. (B) Arteriographic study in a patient with acute carbuncle of the upper pole of the right kidney. Notice that in this patient, there is poor branching and poor opacification of the vessels within the upper pole. The vessels are likewise spread apart. (C) Carbuncle in the lower pole of the left kidney. The patient had been on antibiotics and the vascular changes are somewhat subtle despite the fact that the intravenous pyelogram obtained several days before had shown a mass within the lower pole. Nevertheless, the vessels in the lower pole demonstrate a paucity of branches and in general are poorly opacified, particularly when compared to the upper pole branches.
impaired and slowed. This phenomenon may be partially responsible for the slow perfusion noticed during the studies.

During the nephrographic phase, the normal cortico-medullary junction is frequently lost and replaced by a diffuse and relatively homogenous blush outlining the suggested mass noticed on the previous examinations (Fig. 7). This feature, when present, is both distinctive and important. In 1 patient who presented with a well localized acute carbuncle in which the vascular features were subtle, the loss of the cortico-medullary junction was diagnostic (Fig. 7). The over-all increased permeability and diffusion found at the capillary and venule level is responsible for this feature. In addition, most of the other findings described under the paragraph of nephrography may be seen in this stage.

**Differential Diagnosis**

The roentgenographic findings of acute carbuncle in the kidney must be distinguished from other interstitial processes that may involve this organ; e.g., edema, interstitial nephritis, infiltrating tumors, etc. In all situations, the combined features noted on preliminary studies of interstitial disease, either diffuse or localized, associated with a perirenal inflammatory process should suggest the diagnosis of an acute carbuncle. Most other interstitial renal diseases do not demonstrate perirenal extension. In the differential diagnosis of renal mass lesions, the findings of the acute renal carbuncle noted at arteriography are characteristic, in which one encounters the absence of mass displacement despite previous features of a mass. The presence of either renal cell or renal pelvic carcinoma is also easily excluded in this phase, since these neoplasias are associated with a specific neovascularity. In some pelvic tumors, particularly of the squamous variety, diffuse interstitial spread may be the only manifestation of the disease, and differentiation from an acute carbuncle may be difficult. However, the acute renal car-

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**Fig. 7. Nephrographic phase.** This is the patient seen in Figure 6C. There is a distinct loss of the cortico-medullary junction in the lower pole. The normal upper part of the kidney is within normal limits. A diagnosis of an acute renal carbuncle was made, but because of the lack of clinical symptomatology, the patient was not adequately treated. As predicted, she returned 10 days following the study with an exacerbation of the symptoms, and, at surgery, an acute carbuncle within the lower pole of the left kidney was drained.

The affected vessels branch sparsely and appear denuded (Fig. 6, B and C). Poor and slow perfusion within the infected area may also be apparent. Multiple factors probably account for these changes. The relatively poor arborization of the vessels is apparently caused by compression of these vessels by the surrounding inflammatory infiltration. It has also been demonstrated that in the presence of an inflammatory process, an extensive capillary network becomes functional. This network is always existent, but under normal conditions nonfunctioning. When operational, normal exit via existing venule pathways is distinctly
bunale rarely invades the collecting systems directly. The distinction of neoplasm from chronic renal carbuncle, however, may be difficult since the latter has a highly developed abscess wall with neovascularity. Renal vein thrombosis is easily distinguished from the diffuse acute carbuncle when either the collateral venous circulation or the thrombus is demonstrated.

**DISCUSSION**

From the above findings and an analysis of the patients and their presentation (Table 1), a few interesting clinical and pathologic suggestions are noted. These, however, require further confirmation. In 2 of the 6 cases, the process was overwhelming and involved the entire kidney. Both these patients were males, above 50 years of age, and had prostatic disease, carcinoma in one patient, and benign hypertrophy in the other. The renal infection evolved as an ascending infection in which the causative agents were gram negative in origin.

The remaining 4 renal infections were of hematogenous origin. Interestingly enough, three were females, all in their twenties, and all suffering from drug addiction. The remaining patient was a young male with furunculosis. In contrast to the diffuse renal involvement associated with the ascending infections encountered in the elderly males, the renal carbuncles of hematogenous origin were all localized in nature. It is therefore conceivable that a definite pathologic pattern of the acute renal carbuncle may be present.

As far as the over-all roentgenographic features of renal infection are concerned, most have been confined to the diagnosis of acute pyelonephritis with changes limited to blunting of the calyces and dilatation of the ureter. Although the latter has received a great deal of stress in the literature, the features of acute carbuncle are far more impressive and just as vital. Failure to make a prompt diagnosis can result in loss of either the kidney or the patient.

Moreover, the clinical picture may be obscured when the patient is partially treated with antibiotics. This stimulates the carbuncle to further coalesce, wall off, and proceed into the subacute or chronic phase. Inadequate therapy may also allow further perforation of the infection with involvement of surrounding neighboring structures. Consequently, early institution of therapy, either medical or surgical, is imperative and will often salvage the kidney.

The radiologist should now be alerted to this diagnosis, if and when the clinical status suggests an underlying infective process and the roentgen findings are as described above.

**SUMMARY**

The roentgenographic findings of acute renal carbuncle observed in 6 patients are described. Basically, these findings consisted of:

1. Interstitial disease associated with perirenal involvement demonstrated on preliminary studies;
2. No mass displacement of the vessels in the involved area on angiography despite the suggestion of a mass on the earlier examinations;
3. Loss of the cortico-medullary junction on the nephrogram.

The early diagnosis of acute carbuncle is essential since prompt therapy may salvage the kidney. With the ever increasing problem of drug addiction and its associated complications, acute renal carbuncle is slowly becoming a common disease of youth.

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