Peptic Ulcer Perforation of the Gastroduodenal Artery Complex:

Clinical Features and Operative Control

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A HIGHLY lethal form of exigent hemorrhage due to peptic ulcer is that which occurs consequent to perforation of the gastro-duodenal artery, its bifurcation, or either major branch, in the base of a large juxtapyloric ulcer. This arterial lesion has distinctive clinical characteristics, is identifiable by discernible findings at operation, and requires a unique method of precise arterial ligation to achieve absolute hemostasis.

Perforations involving the gastroduodenal artery complex occur as a sequel to transmural ulceration of the posterior duodenal wall. Such erosion excavates the pancreas on each side of the more resistant artery, leaving a portion of the circumference of a segment of the vessel protruding from the relatively non-fibrotic pancreatic base of the usually large ulcer. Subsequent ulcerative perforation of the exposed artery involves only a small area of the vessel and is usually located centrally in the ulcer bed. The remainder of the exposed artery does not show erosive changes. We have seen at operation an arterial ulcer with a pulsating expansile base in which there was a small hole through which the hemorrhage occurred. However, in most instances the arterial perforation does not have the appearance of an ulcer because the entire base has been blown out. The relatively small size of the perforation and the usual absence of visibly eroded margins mask the ulcerative process. Although the perforative mechanism is primarily ulcerative, the acute hemorrhage is due to hemodynamic rupture of the base of the arterial ulcer. When the situation is studied at necropsy and the interior of the artery visualized by a longitudinal incision through the exposed anterior wall, the ostium of a large artery is frequently seen opposite the perforation (Fig. 1).

At operation the bleeding is usually found to have stopped and occasionally careful scrutiny may be necessary to identify the artery in the ulcer base. The site of the arterial perforation is detected by identification of the occluding thrombus which may be yellow, gray, or dark red.

Peptic perforation involving the gastroduodenal artery complex characteristically produces an eruptive hemorrhage of major magnitude. Occasionally the perforation is so large that exsanguination occurs; occasionally so small that early thrombotic occlusion occurs without massive blood loss. With the usual perforation the clinical features are those inherently associated with a precipitous and large reduction in blood

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FIG. 1. Necropsy specimen. 1. Margins of large posterior duodenal ulcer. 2. Perforated arterial ulcer of the gastroduodenal artery which has been opened by a longitudinal incision. 3. Ostium of anastomotic artery.

volume. The consequent severe hypotension permits thrombotic occlusion of the perforation with cessation of the bleeding (Fig. 2). After a period of time, usually several days or less, dislodgement of the thrombus commonly occurs and results in a recurrent eruptive hemorrhage similar to the first. This dislodgement is consequent to peptic, tryptic, or other lytic clot digestion, clot retraction, and elevation of the blood pressure. An additional factor is the hemodynamic pressure exerted on the luminal thrombus from the arterial opening opposite the perforation. Eruptive hemorrhage recurring within several days after complete cessation of bleeding is the consummation of the characteristic clinical picture of perforation of a major artery in the base of a peptic ulcer, either gastric or duodenal.

The malignance of the process is the basis of the precept that a recurrent major eruptive hemorrhage is an indication for acute phase operative intervention. This intervention is needed even though the second hemorrhage ceases, in order to prevent a third hemorrhage which frequently will be fatal.

The perforated artery in the base of a chronic juxtapyloric duodenal ulcer is commonly considered to be a single vessel with no branches. Actually bifurcation of the gastroduodenal artery into its two branches, the right gastro-epiploic and superior pancreatico-duodenal arteries frequently occurs retroduodenally. This bifurcation may occur at any level between the superior and inferior borders of the duodenum. Peptic perforation occurring at the bifurcation creates a three-vessel operative

FIG. 2. Appearance of artery in ulcer bed. Eruptive hemorrhage followed by thrombotic occlusion of the arterial perforation.

problem. Another anatomical arrangement characteristic of the gastroduodenal artery complex consists of the right angled anastomosis of the transverse pancreatic artery with the gastroduodenal artery or either of its two branches. Perforation at this junction creates a second three-vessel situation (Fig. 3). The foregoing establishes that there are four possible ways that arterial perforation of a "T" or three vessel junction may exist in the bed of a juxtapyloric duodenal ulcer. These critically important anatomical features have been clearly elucidated by the dissections of Michels.[2]

Exigent rebleeding is reported as a frequent complication following vagotomy, pyloroplasty, and "suture ligation" of the bleeding point whenever hemorrhage arises from a chronic duodenal ulcer. In our opinion the frequency of such rebleeding bears a relationship to the depth and diameter of the ulcer, which are usually proportionate, and therefore to the frequency of involvement of the gastroduodenal artery complex. In such cases major rebleeding is most often due to imprecise application of suture ligatures. This imprecision is due to failure to recognize that the "point" of perforation is frequently located opposite a "T" juncture of the perforated artery and a major bifurcative branch or an anastomotic artery. The perforated artery represents two vessels and the branch or anastomotic artery a third vessel, each ending at the perforation. To avoid early rebleeding, operative control of these three open-ended arteries requires separate circumferential ligation of each. Such circumferential ligation is a

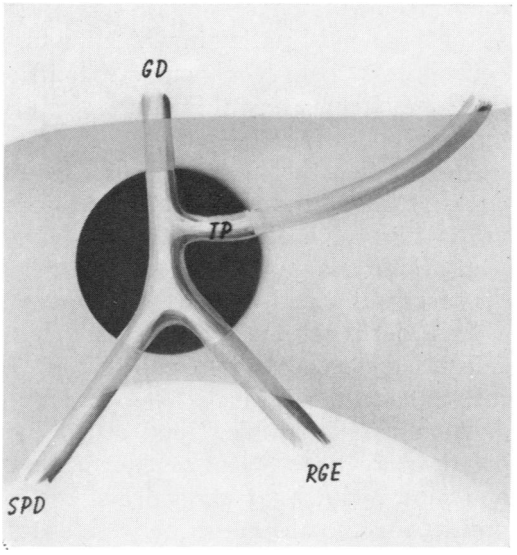

FIG. 3. Gastroduodenal Artery Complex. The two major types of "T" intersection are illustrated. Arteries: GD—gastroduodenal; TP—transverse pancreatic; SPD—superior pancreatico duodenal; RGE—right gastro-epiploic.

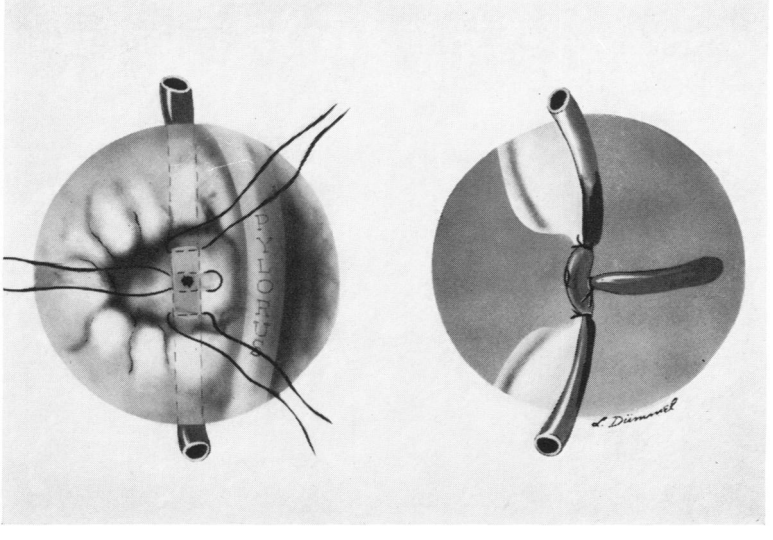

FIG. 4. Method of achieving circumferential "three vessel" ligation. The diagram shows how the site of the arterial perforation determines placement of the horizontal mattress suture. Tying of the "U" stitch achieves circumferential ligation as illustrated in the cross-sectional diagram.

fundamental principle of vascular surgery. In the anatomical setting in which the foregoing occurs, there is only one way to place the three circumferential ligatures essential for precise ligation[1] (Fig. 4).

At operation the ulcer can often be exposed satisfactorily using the gastroduodenal incision of a Heinke-Mikulicz pyloroplasty. With a large posterior ulcer or when the ulcer is situated low in the duodenum, a long duodenal incision is desirable to gain adequate exposure of the ulcer. In such instances, a Finney type gastroduodenotomy is preferable. The partially exposed artery in the base of the ulcer can be almost invariably identified by close inspection. In the absence of active bleeding the arterial perforation can be detected by the thrombus in it. In the uncommon case where a thrombus cannot be identified, restoration of the patient's blood pressure to normal may assist in restarting the bleeding and reveal the site of perforation.

After identification of the perforated artery, the three circumferential ligatures should be placed and the two surrounding the exposed artery are tied. The thrombus is then extracted, which usually results in a spurting hemorrhage, establishing the presence of a T or three-vessel complex. The consequent bleeding must be then controlled by tying the third ligature (the "U" stitch) proving that the ligatures have been properly placed. Ideally the final testing should be done in the presence of a normal blood pressure.

Approximation of the ulcer margins by interrupted sutures is done to temporarily shield the ulcer base and ligatures from proteolytic enzymes. The pyloroplasty is then closed and the vagotomy done. This concurrent ulcer-curative operative procedure is essential. The magnitude of an ulcer-curative operation should be the minimum necessary to control the ulcerogenic mechanism. This latter requirement is best met by vagotomy and pyloroplasty, which provide amazingly rapid healing of the duodenal ulcer. The operative procedure is concluded by a temporary tube gastrostomy.

An ideal suture material for the arterial ligation does not exist. The occasional failure of catgut, due to its digestion by pancreatic enzymes, is counterbalanced by the occasional problem of "silk ulcer." There is no available controlled evidence as to which type of existing suture material is superior. For the arterial ligation we use #0 chromic catgut (Type C). However, regardless of the suture material used, individual ligation of each of the three vessels can only be accomplished by the method described and such precision ligation is fundamentally and critically important for the control of hemorrhage due to peptic ulceration of the gastroduodenal artery complex.

References

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