

# CHOLEDOCHO-ENTEROSTOMY AND POSTOPERATIVE DILATION OF THE BILE-DUCTS

AN EXPERIMENTAL STUDY

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SUTURE operations are quite often undertaken upon the common bile-duct in human surgery because the dilation of pathologic ducts makes them practicable. There are conceivable emergencies in which one may be forced to unite a small-sized common or hepatic duct to a loop of intestine or to the stomach and in which an oblique anchorage method may be helpful.

According to Baudouin, the first apparent attempt to perform choledochoenterostomy belongs to Riedel. Riedel, in 1888, endeavored to close a choledochostomy by suturing the bile-duct to the intestine. In 1890 Kocher failed to overcome a bilioduodenal fistula by a plastic operation upon the end of the bile-duct. In the following year, the first successful choledocho-enterostomy was carried out by Sprengel in a woman upon whom he had first done a cholecystectomy.<sup>1</sup> Guerry<sup>2</sup> has recently reported four symptomatic cures out of seven direct anastomoses. Mayo's<sup>3</sup> studies and successful case, published in 1905, emphasized the possibilities of end-to-end common duct and of end-to-side bilioduodenal union. Foreign substances have been introduced by Horsley,<sup>4</sup> Lewis,<sup>5</sup> Davis,<sup>5</sup> and others in efforts to abridge the gaps between the intact ends of partially destroyed bile-ducts. To this end, veins, fascia, and the appendix have been proposed but have not met with promising success. Sullivan's<sup>6</sup> suggestion of the use of the rubber tube has probably met with the most favor in this respect. At the present time, the indications appear to be for direct anastomosis when possible, and for indirect union by means of a rubber tube, as proposed by Sullivan and developed by Mayo, when necessary.

Any procedure to reunite a partially destroyed bile passage is made difficult by the inaccessibility of the operative field and by the large numbers of adhesions. A destruction of the common duct where the gall-bladder is absent or, for other reasons, unavailable for cholecystenterostomy impels the prosecution of some form of choledocho-enterostomy. In isolated instances, hepatico-enterostomy has been tried in spite of the dangers of liver abscess and of the difficulties of suturing gut to liver. On one occasion, Stewart<sup>7</sup> opened the duodenum and sutured it about the portal fissure in the hope that bile would eventually find its

## CHOLEDOCHO-ENTEROSTOMY

way into the intestine. Tumor, calculus, or stricture may seriously interfere with the entrance of bile into the intestine. A duct may be divided or resected intentionally or accidentally at operation or it may be severed in a gunshot wound\* by a bullet passing through the abdomen. The frequency of these causes of duct injury, in which choledocho-enterostomy may have to be resorted to, is well shown in Mayo's statistics of 159 common duct operations out of 1100 operations upon the liver and bile passages with complete loss of continuity of the common duct in 7. Of these, 5 were severed purposely during resection for carcinoma, 1 was unintentional, and 1 followed extensive operation for gall-stone disease.<sup>8</sup>

The following experiments are based in part upon experience in ureterocolostomy and in part upon the reports of others on bilioenteric anastomosis. As may be seen from the illustrations, the ligated bile-duct is drawn through the submucosa of a mobilized loop of small intestine or stomach, into the lumen of the same, and left fixed by the ligature in the exit needle-puncture opening. The end of the duct within the lumen of the bowel and below the ligature may be incised to provide for the immediate escape of bile, or, apparently, this step may be omitted with impunity, for, under the conditions of the experiment, bile may not enter the distal part of the transposed duct within two days, and the duct ends are found free in three days. Ninety per cent. of the animals represented had transplantations without this provision for spontaneous bile drainage. It is important not to disturb the terminal fascial connections of the duct any more than is absolutely essential. As in the ureteroenteric transplantations, the operative technic is simple and free from local infections but subject to the dangers of bile-duct dilation and ascending biliary infection.

Autopsies performed at various times during the postoperative life of these animals disclose many interesting findings. Ascending infection of the liver unfortunately has not been excluded and may have caused the death of certain of the apparently successful animals. In those instances in which the bladders were dilated, the livers, too, were deeply congested. In all the experiments, the ducts are found dilated, no matter at what time examined. At the end of the second day, the intramural segment is remarkably firm, due, apparently, to the fascial connections outside the bowel, to the exudative and fibrinous agglutination of the omenta, liver, and anastomotic loop, and to the enlargement of the intrainestinal end. The ligated end early retracts within the lumen, becomes swollen and congested, is free from the ligature in about three days, and ultimately disappears altogether. There is no evidence of persistent irritation about the new opening, which is beyond detection excepting at such times as bile is seen to come from it. The needle punctures and ligature-suture are amply protected by exudative material and scar tissue. The mucosa,

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\* One gunshot wound of the common duct came under the department of surgery and was operated upon by Cramp during the past year.

of the intestine is continuous with the lining membrane of the bile-duct in most of the transplants and is interrupted in some, but not all, of the badly obstructed animals (Fig. 8). In the great majority of the dogs, the bile-duct, anastomosis, and the anastomotic intestinal loop are free from gross and microscopical evidence of disease aside from the biliary dilation which, to some extent, is common to all.

This dilation appears in the ureteral transplants<sup>9</sup> as it does in these animals after gall-duct transplantations and is evidently of nervous origin. In studying the relation of trauma to the neuromuscular function of the ureter, it was shown that the regular contractile wave in the dog's ureter recurred at nine-second intervals, but that when the nervous connections in the wall were impaired this peristaltic wave dropped off to twenty-five and sixty-nine second intervals, respectively, according to the degree of ureteral trauma. In many of these animals with known disturbed ureteral nerve connections, hydroureter and hydronephrosis developed. The relation of these dilations to possible nervous causes has recently been emphasized by Braasch.<sup>10</sup> In respect to the bile-duct, peristalsis, as far as I am aware, has not been observed and can not be studied in relation to trauma, but dilation certainly does follow division and transplantation. The bilioduodenal sphincter (sphincter of Oddi), like the ureterovesical "valve," stands as a barrier between open and closed systems against harmful pressure changes and ascending infection. These functions are well illustrated in Archibald's<sup>11</sup> excellent work on the biliary system. The direct nervous connections of this sphincter with the bile passages on the one hand and with the duodenum on the other are destroyed in division of the common duct. This interference with the neuromusculature of the duct and the loss of the "valve" probably unite to cause that apparently harmless biliary dilation occurring in all transplantations.

The present series comprise twenty animals, fourteen of which are successes barring the dilation above described and the possibilities of ultimate ascending infection of the liver, and six are partial or complete failures due to harmful compression of the intramural segments of the transposed bile-ducts. Four of these failures occur in the thick-walled stomach and two in the duodenum. In the relatively thin-walled jejunum the stomata are the most patent.

The following conclusions suggest themselves:

1. A severed bile-duct too small for sutures but long enough for direct choledocho-enterostomy may be reunited to the upper small intestine or the stomach by anchoring it obliquely within the wall of the intestine or the stomach.
2. Of twenty animals, eighteen, with temporarily obstructed ducts, developed patent functioning anastomoses in 72 per cent., and two with provision for spontaneous drainage. Of these latter, one animal has had a perfectly functioning anastomosis for four months.



FIG. 1.—This represents the first stage in bilioenteric anastomosis. The common bile-duct has been divided distal to a ligature with the ends left long, as indicated. It is apparently not necessary to ligate the duodenal end of the divided duct, for in no instance has leakage been found to have occurred from the united stump. A loop of small gut is brought up into the wound and in the vicinity of the free end of the duct.

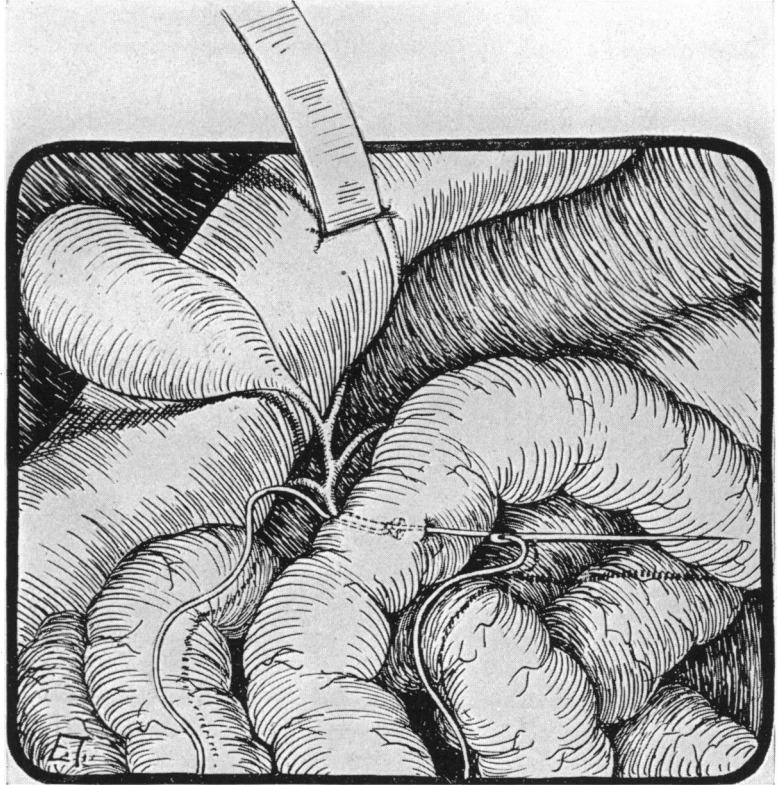


FIG. 2.—A straight, fairly large-sized needle is attached to an end of the ligature and is run through the intestinal wall for a distance of 1.5 cm. The needle and duct are made to enter the lumen of the bowel and, immediately, to emerge perpendicularly. The trailing end of the ligature is recovered and held.



FIG. 3.—This exposed and ligated end of the bile-duct is fixed in the exit from the bowel by a simple anchorage suture. The original ligature is utilized for this suture, as indicated.

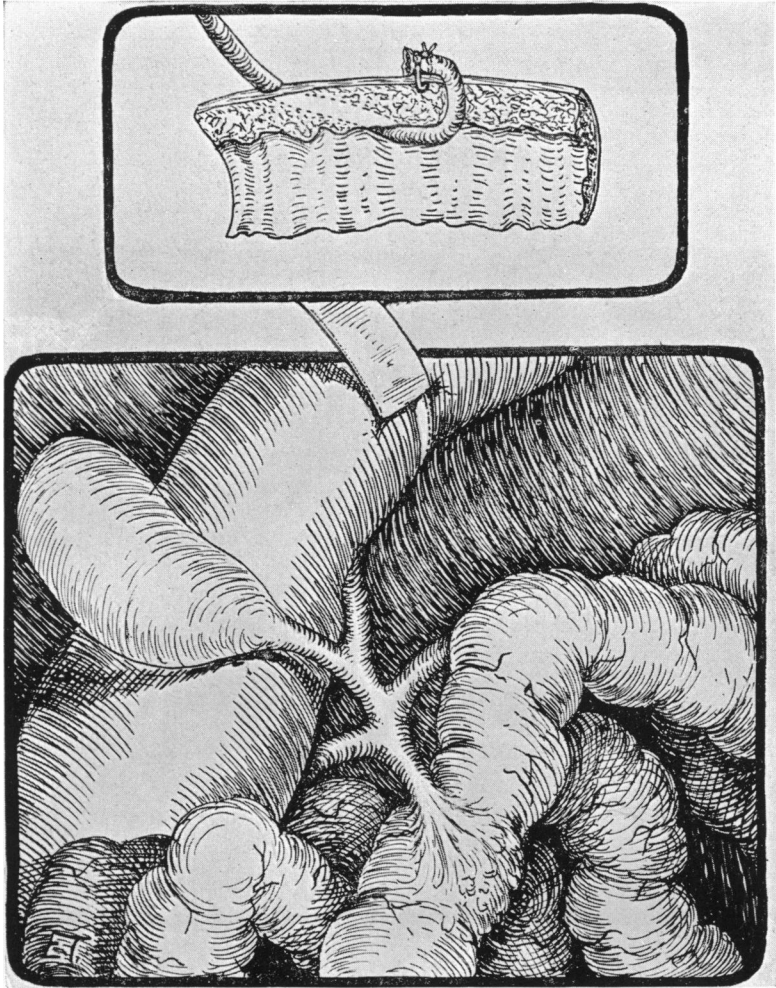


FIG. 4.—This represents an after-result and is taken at random from one of the "intact" animals. Note particularly the degree of gall-duct dilation. The insert above shows the relationship of bile-duct to intestinal wall and to lumen of bowel immediately after operation. Retraction probably always occurs, making leakage at exit impossible.

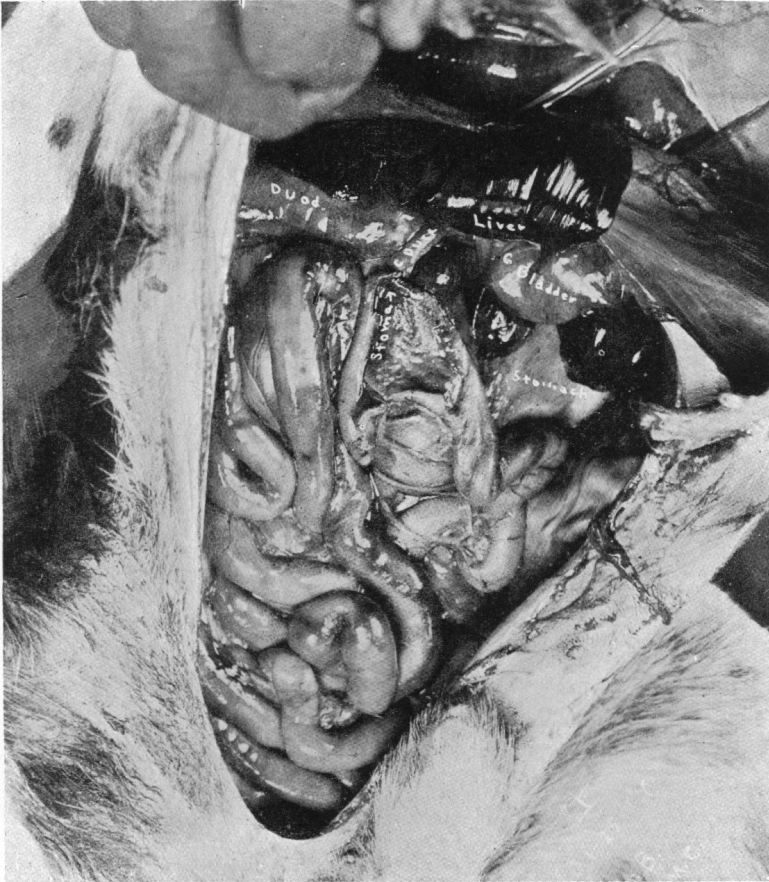


FIG. 5.—This is a photograph of a similar animal after euthanasia. Note loop of intestine opened up and duct stoma. This opening is free from evidence of irritation and can be discerned only by watching for the appearance of bile during pressure over bladder. Note relative sizes of duct and bladder.



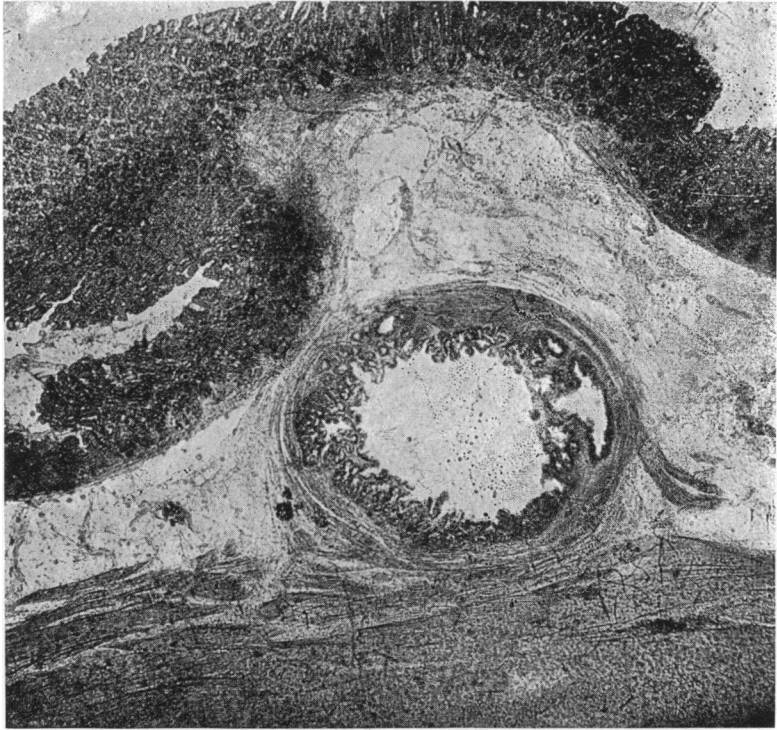


FIG. 6.—Microphotograph of a cross-section of an "intact" bilio-enteric anastomosis. Note duct lying in submucosa of intestinal wall. Note size of duct lumen and integrity of duct wall.

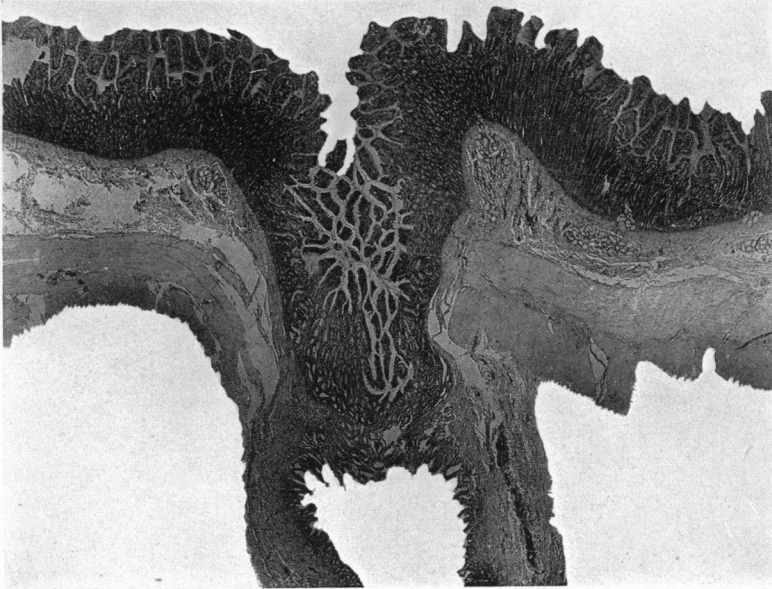


FIG. 7.—Microphotograph of a longitudinal section of a successful bilio-enteric anastomosis. Note relative sizes of intramural and extramural bile-duct, transition of lining epithelium, and integrity of duct wall.

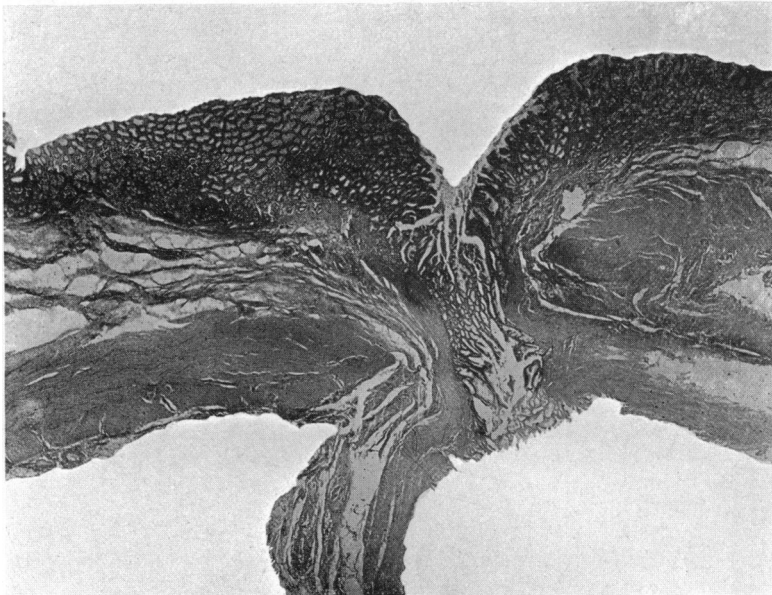


FIG. 8.—Microphotograph of a longitudinal section of an unsuccessful bilio-enteric anastomosis. Note marked dilation of extramural duct as compared with the intramural segment, diminished size of the intestinal portion, and beginning disintegration of the bile-duct, presumably from increased pressure.

## CHOLEDOCHO-ENTEROSTOMY

3. A certain degree of dilation due to the inevitable interruption of the nervous connections during reconstruction of the bile-duct is not incompatible with life. Harmful dilation is associated with retraction of the transposed end, obstructive intramural scar, and deficient epithelialization.

4. The above technic reduces to a minimum the adhesion-forming traumata, and the factors in it tending to prevent the retraction and obstruction of the bile-duct are: (1) Proper mobilization of the anastomotic intestinal loop, (2) the oblique course of the intramural segment, (3) possibly the dilation of the intrainestinal end, and (4) anchorage of the bile-duct with due allowance for retraction.

### SERIES NO. 1. EXPERIMENTAL CHOLEDOCHOGASTROSTOMY

Serial No.	Exp. No.	Postop. Life in days	Anatomical result: Gross and microscopic		Physiologic
1	4	23	Retraction; obstruction	.....	No bile on pressure.
2	11	32	Retraction; obstruction	.....	No bile on pressure.
3	18	17	Intact.....	Continuous layer of epithelium	Bile on pressure.
4	20	24	Partial retraction; obstruction	.....	Bile on plus pressure.
5	33a	10	Intramural stenosis	Obliterative inflammation	Bile on plus pressure.
6	28	44	Intact.....	Continuous layer of epithelium	Bile on pressure.
7	42	35	Intact.....	Continuous layer of epithelium	Bile on pressure.
8	69	59	Intact.....	.....	Bile on pressure.
9	33	99	Intact.....	.....	Bile on pressure.

The duration of life represented in Series 1, 2, and 3 does not give the number of days the animals could have lived; for in many instances the experiments were terminated by euthanasia.

### SERIES NO. 2. EXPERIMENTAL CHOLEDOCHODUODENOSTOMY.

Serial No.	Exp. No.	Postop. Life in days	Anatomical result: Gross and microscopic		Physiologic
1	12	38	Intact.....	Continuous layer of epithelium	Bile on pressure.
2	1	49	Intact.....	.....	Bile on pressure.
3	43	25	Intact.....	Continuous layer of epithelium	Bile on pressure.
4	35	42	Intact.....	Continuous layer of epithelium	Bile flows spontaneously.
5	27	68	Intact.....	Continuous layer of epithelium	Bile on pressure.
6	32	60	Retraction; obstruction	.....	No bile on pressure.
7	41	41	Retraction; obstruction	.....	No bile on pressure.
8	94	120	Intact.....	Continuous layer of epithelium	Bile flows spontaneously.

WILLIAM HOWARD BARBER

SERIES No. 3. EXPERIMENTAL CHOLEDOCHOJEJUNOSTOMY

Serial No.	Exp. No.	Postop. Life in days.	Anatomical result: Gross and microscopic		Physiologic
1	40	19	Intact.....	Continuous layer of epithelium	Bile flows spon- taneously.
2	62	?	Intact.....	.....	Bile on press- ure.
3	70	17	Intact.....	.....	Bile flows spon- taneously.

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