

The use of axial drainage in biliary surgery

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Abstract— The axial drainage, used since the beginning of the 20th century, with indubitable advantages in comparison with the other biliary drainage methods, has constantly been in specialists' attention, which along the years allowed for an improvement and diversification of the ways it is practiced. This study emphasizes the value of the transligamentary axial drainage in biliary surgery by references to the aspects connected to its use on a nine years period at the Bucharest Caritas Hospital Surgery Clinic, where this procedure was developed and used over time in innovative ways and then continued at the Bucharest Oncology Institute's Surgery Clinic I. This method's indications and advantages, but also the high percentage of use and exceptional obtained results recommend the axial drainage as the best method of drainage of the common bile duct based on the experience of the specialists working in these clinics.

Keywords— axial biliary drainage, common bile duct surgery, extraperitoneal route, stenting of biliary-digestive anastomoses

I. INTRODUCTION

OVER time, axial drainage has achieved a well deserved position in the classic surgery of benign and malignant obstructions of the common bile duct. Although nowadays the trend is not to drain anymore, still in a number of situations this procedure cannot be avoided and the drainage has proven its utility. Thus, the theme of the drainage may not seem anymore a current topic having in view the advances in the robotic, laparoscopic, and laser surgery [1], but neither the classical surgery nor the axial drainage will disappear. The execution manner offers a lot of advantages, but despite them it is not very spread because it is not known and it was not well promoted. As a consequence the percentage in which it is used is small. But axial biliary drainage is performed routinely in some surgical clinics in Romania. And starting from a short listing of the important names related to the evolution of this external biliary drainage method, the study sets out to present the experience of Bucharest Caritas Hospital Surgery Clinic and Bucharest Oncology Institute's Surgery Clinic I with respect to axial drainage for the patients included in the study

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group and makes a brief review of this drainage method's indications and advantages.

II. AXIAL DRAINAGE OF COMMON BILE DUCT

Used as early as the beginning of the previous century, axial drainage (Fig. 1) has been a constant pursuit for those who understood its value, the method having been modified for improvement or for overcoming the different inconveniences observed over the years of surgical practice. The cumulated experience and trials conducted over the years regarding axial drainage may be illustrated by referencing a series of specialists' names that have contributed to the widespread usage of axial drainage.

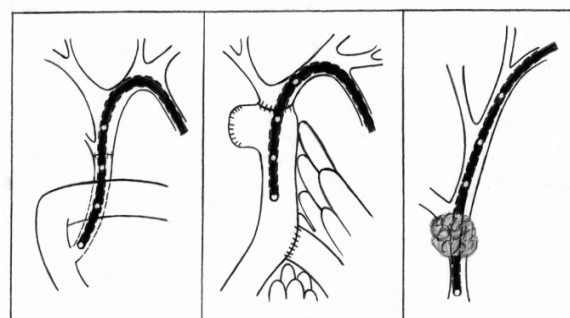


Fig. 1 The main uses of the axial biliary drainage: (a) Surgery of the common bile duct; (b) Stenting of the biliary-digestive anastomoses; (c) Transtumoral drilling

The first to be remembered are Hoag (1937) who performs an anastomosis of the gastric ducts that he protects with a transanastomotic tube, by externalizing the transhepatic drain, and Cole (1948) who uses this technique in a biliary jejunal anastomosis. Goetze reports in 1951 and 1959 about using the U axial tube for the treatment of the common bile duct strictures. Claggett and Braasch use in 1954, for the first time in the USA, the transhepatic drain. Altemeier performs in 1957 the intubation through transtumoral drilling in ductal carcinomas. Transhepatic stenting is used in cases of duct stenosis by Quijano in 1957 and Munoz in 1959 and then by Praderi [2], [3] in 1961. In 1958 Magoon and Claggett perform the transhepatic intubation of some biliary jejunal anastomoses, and in 1964, by publishing his experience regarding the transhepatic stenting of the hepaticojejunostomy, Smith is the one to impose the axial drainage, thus the method being connected to his name [4]. Subsequently other

specialists who had further developed the method and communicated their results regarding transhepatic axial drainage such as Saypol and Kurian (1969) [5], Terblanche (1972) [6], Cameron (1969) [7], Heydenrych (1969), Stoppa (1980) [8] – [10] a. o. can be mentioned [11]. More recently Tsunoda et al. (1991) and Goseki et al. (1998) [12], [13] can be mentioned for the method of extraperitoneal axial drainage which they developed.

In Romania, axial drainage in its transhepatic variant was used for the first time in April 1965 by Burlui and his collaborators [14] – [16]. Later they improved the technique [17], [18] and developed an original method which was published in 1971 in *Presse Médicale* [19] – [26]. The method externalizes the drainage tube on a strict extraperitoneal route, through the repermeabilized omphalic vein, and then the procedure was simplified by externalizing the axial drainage tube between the round ligament's sheets. Brătucu has generalized the use of this method in the clinic and proposed new indications and innovative ways of use (Fig. 2) for this type of drainage [11], [27], [28].

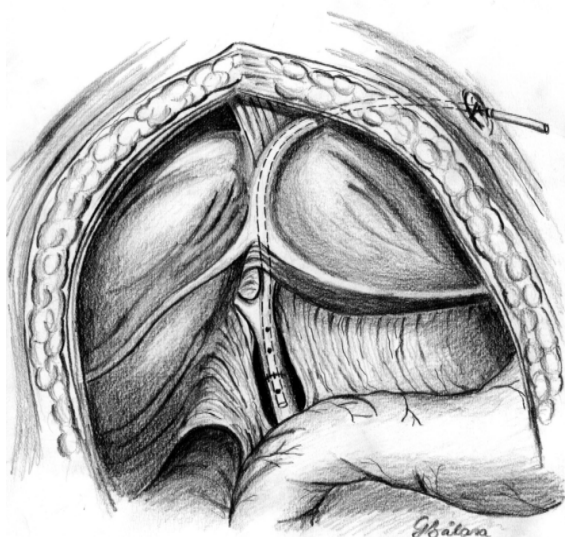


Fig. 2 Axial biliary drainage after choledochorrhaphy

The installation of the drainage requires a special tool, a curved metallic instrument to which the tube is hooked and it was pulled on transhepatically in the biliary ducts. Subsequently, Brătucu and Ulmeanu have improved this instrument, that is they created a lumen with a detachable cone-shaped tipped mandrel which does not cause injuries to the biliary and vascular structures when it is introduced [29].

The instrument (Fig. 3) is stainless and it is of different calibers and curvatures and allows for the advancement of the drain tube through the instrument's lumen and not pulled on by it, thus diminishing the risk of lesions of the hepatic parenchyma and the risk of hemorrhage.

Inspired by Rodney Smith's technique in 1995 Brătucu imagined and practiced for the first time the original technique of sutureless hepato-jejunal anastomosis (Fig. 4), by using the

axial biliary drainage. "The method realizes anastomosis of the segments without using sutures by simply keeping them in apposition with continuous traction exerted via a Foley-type balloon catheter which stents the anastomosis in an axial manner. The balloon is then inflated and traction is exerted on the catheter, enabling the two segments of the anastomosis to remain in place until complete healing (10 days average) [30]."

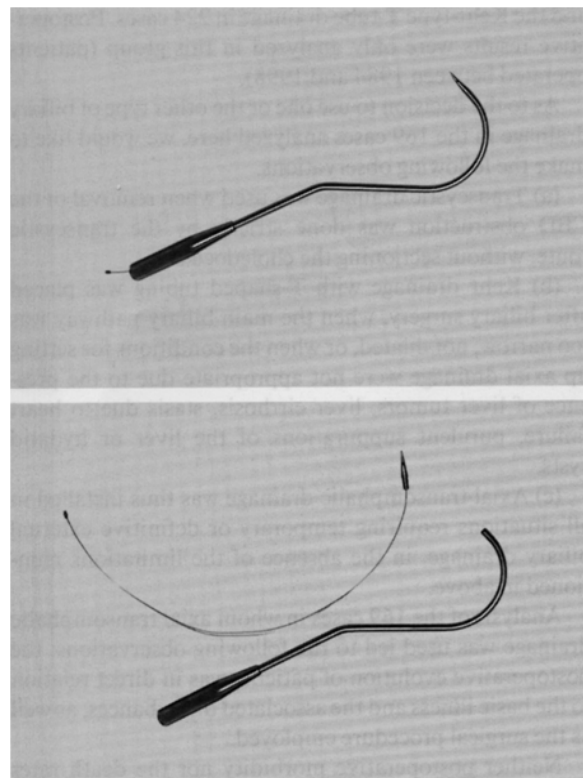


Fig. 3 The instrument for axial biliary drainage designed in the Bucharest Caritas Hospital Surgery Clinic

This procedure may be used in high anastomoses in a single way with the common bile duct or it may be performed in a double way (Fig. 5) with separate anastomoses for the right hepatic duct and the left hepatic duct.

This method has proven to be very useful in the high iatrogenic lesions of the common bile duct during the laparoscopic interventions with a remaining short biliary stump, friable, inappropriate for anastomoses performed in a traditional way [31] – [33].

Another innovative method of using the axial biliary drainage is after the cephalic duodenopancreatectomy when, with a single axial drainage it is possible to simultaneously ensure the drainage of both anastomoses (hepaticojejunal and pancreaticojejunal) [34].

Besides the benefit of using a single drain tube, this drainage method also offers the advantage of extracting the pancreatic drainage at the same time with the biliary one. The images (Fig. 6, 7) exemplify our method of executing the post-procedure anastomotic arrangement, as well as the axial drainage.

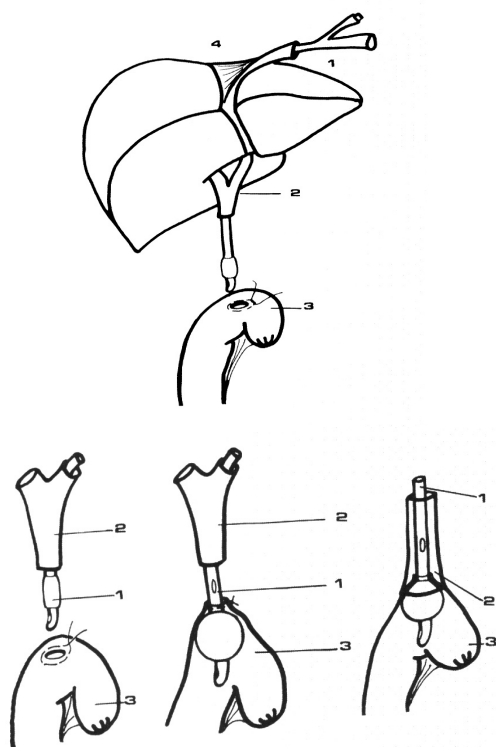


Fig. 4 Hepaticojejunostomy without suture – Brătucu's original technique

III. SURGICAL TECHNIQUE

In the following, we shall describe the axial biliary drainage installation technique in a transligamentary way (variant currently used in our clinic and offering a complete extraperitoneal trajectory).

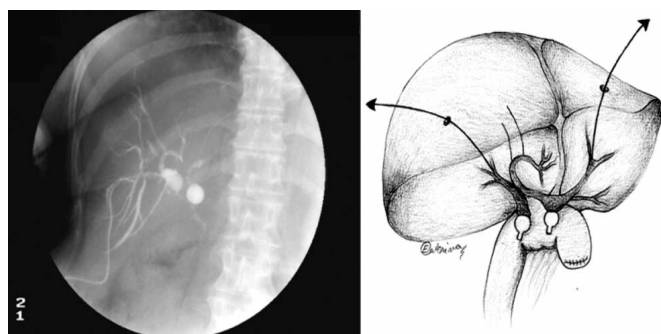


Fig. 5 (a) Postoperative control after double hepaticojejunostomy; (b) Postoperative cholangiographic biliary map

The Burlui technique, by the repermeabilization of the omphalic vein, has a historical value and is no longer used because of the technical difficulties. The transhepatic variant, externalized on the right side, unavoidable in certain situations, does not offer the advantages of the strictly extraperitoneal route, although it is easier to perform.

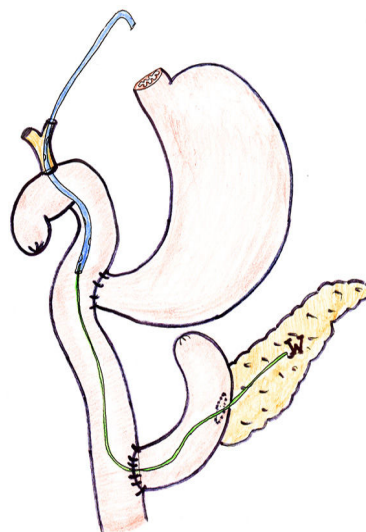


Fig. 6 Single axial drainage in our anastomotic arrangement after cephalic duodenopancreatectomy for biliary-hepatic anastomosis and for pancreaticojejunostomy

The installation technique uses the instrument described earlier, similar in shape to a Benique, and has two distinct steps, the parietal step and the transhepatic step, in the order preferred by the surgeon.

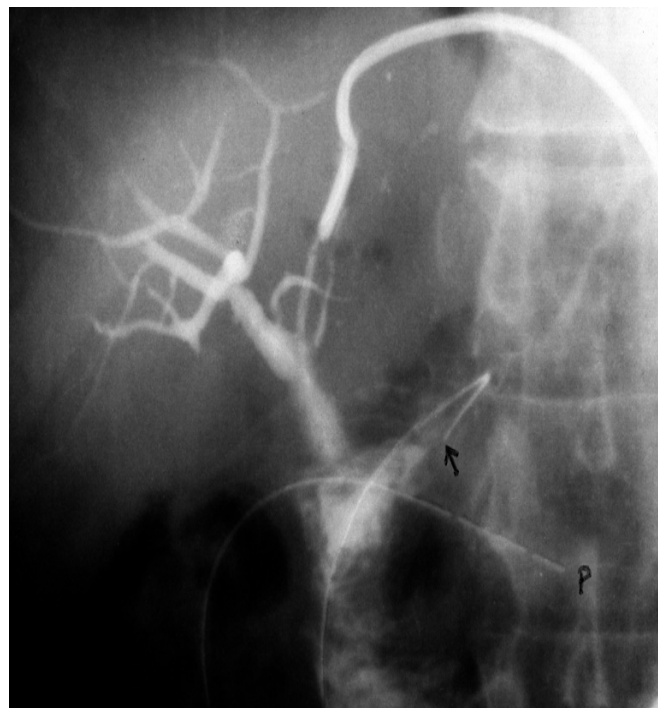


Fig. 7 Radiological postoperative control; P – pancreatic stump

In the parietal step, the drain tube is introduced from the exterior until the round ligament level, which needs to be set out "ab initio". It is performed a small incision at the left

hypochondrium or the epigastrium level, in a convenient position to penetrate the abdominal wall with the axial drainage instrument so that its tip will be externalized between the ligament's sheets above the liver. The tube is introduced through the instrument's lumen, and then the instrument is retracted. Then it follows the main step, the transhepatic step, when the instrument is introduced in the common bile duct, led in the left hepatic duct, then the biliary duct is perforated with the blunt tip of the instrument so that it may be led through the umbilical vein ditch, and transhepatically externalized in the round ligament thickness close to the location where the tube was placed in the previous step. The tip and the catheter are extracted from the instrument and this time in the opposite direction the drain tube is introduced through the distal end of the instrument and pushed until the other extremity of the instrument. The instrument is pulled back and the drain tube is fastened in its final position based on the purpose of the surgeon (biliary duct drainage, anastomotic stenting, transtumoral drilling, and so on). The breach at the ligament level is closed with a thread, thus creating the strictly extraperitoneal route. In case of failing in the externalization of the instrument between the ligament's sheets, this does not represent a problem, as the strictly extraperitoneal route is obtained through a technical artificial means of coupling the tube with the ligament by using some suture threads.

IV. PATIENTS AND RESULTS

The retrospective study we conducted covers the period between 1992 and 2011, during which 386 surgical procedures involving the common bile duct were performed within the Bucharest Caritas Hospital Surgery Clinic and the Bucharest Oncology Institute's Surgery Clinic I. The patients included in the study have been observed from a preoperative biological status, from an intra-operative lesion complex and from the practiced surgical solution point of view, as well as from the point of view of postoperative evolution in dynamics, at a distance and comparatively.

The preoperative and postoperative patient assessment has focused on the following parameters: clinical – fever curve, renewal of bowel movements, jaundice remission, cardiovascular and respiratory status, digestive tolerance; biological – cholestasis indices (alkaline phosphatase, bilirubin), hepatic cytolysis indices (transaminase GOT, GPT, GGT); Hct, Hb, leucocytes; imagistic; postoperative – specific and general postoperative complications (fistulas, anastomotic unbinding, anastomotic stenoses, hemorrhage).

However the purpose of this paper is not to present in detail these aspects with respect to patients included in this study, but to highlight the value of axial drainage in common bile duct surgery by stating the aspects related to using this procedure in the period and clinics mentioned.

Thus, 266 of the procedures were performed for common bile duct lithiasis and 120 for malignant lesions (Fig. 8).

During the mentioned interval the axial drainage was used in 309 (80% of the) cases. For 19 (5%) of the patients the Kehr drainage was used, while for 58 (15%) of the patients the endoscopic oddian sphincterotomy was performed (Fig. 9).

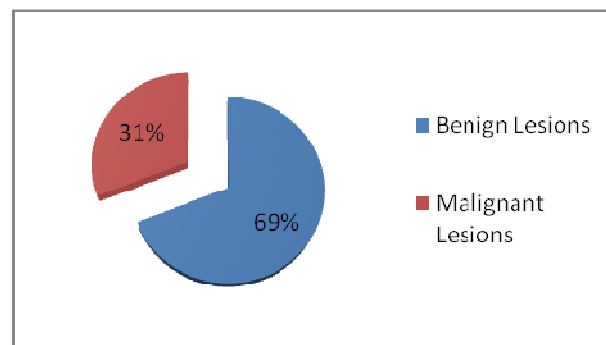


Fig. 8 Types of lesion

With respect to the performed anastomosis types, 70% were common bile duct-duodenal anastomoses, 15% were common bile duct-jejunal anastomoses and for 15% of the patients common bile duct-duodenal anastomoses and endoscopic oddian sphincterotomies were performed (Fig. 10).

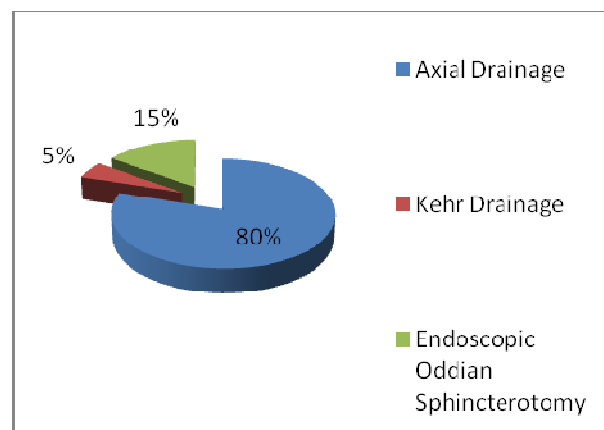


Fig. 9 Types of drainage

The registered complications consisted in minimum and temporary subhepatic biliary leaks (5-6 days) of the subhepatic drain.

No deaths occurred pursuing the used surgical procedure within the analyzed patients' group.

In 3% of cases (12 patients) a non specific mortality was recorded [35].

V. DISCUSSIONS

Axial drainage is the election method used for biliary-digestive derivations performed in case of malignant obstructions and common bile duct neoplasms [36] – [39]. In the surgical practice addressing benign obstructions, the selection of axial drainage depends on a series of elements such as intraoperative difficulties, uncertainties regarding the evolution towards complications or the anastomosis imperviousness and the existing complications. Transligamentary drainage is the best variant, however it is possible only in case of externalizing the drainage tube through the left hepatic duct. The transparietohepatic variant is

used when the stenting of the right hepatic duct is necessary [27].

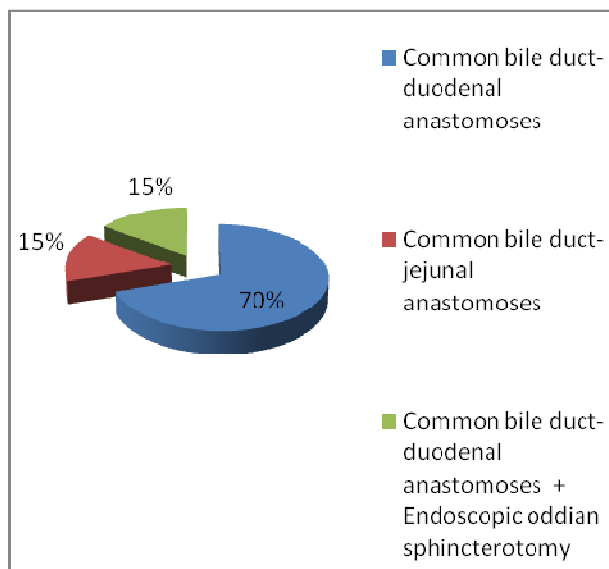


Fig. 10 Types of anastomosis

The indications are similar to the indications of any other type of biliary drainage (Fig. 11, 12) but which in particular situations provide certain advantages. The main indications are represented by the open surgery of the common bile duct lithiasis. It offers protection of the biliary-digestive anastomoses especially when performed in precarious conditions (inappropriate biliary stump). A very important usage is in the stenosis surgery, implying the right and left hepatic ducts. Not less indicated is its use in the iatrogenic lesions, including after laparoscopic surgery. Another indication is the achievement of anastomoses when there is a pedicular fibrosis where the prolonged placement of the drain allows a controlled healing avoiding stenosis. It has also an important place in the palliative surgery of unresectable tumors after transtumoral drilling [40] – [60].

Among the axial drainage counter indications the following may be mentioned: indurated liver lacking elasticity (chronic hepatitis, hepatic steatosis, hepatic cirrhosis and cardiac stasis liver), hepatic hemangiomas concurrently with the intervention, post surgical or posttraumatic hepatic hematomas, frail liver (acute yellow liver dystrophy), recent hepatic traumas, suppurating angiocholitis, hepatic metastases [29].

The advantages of common bile duct axial drainage include: impossibility of contaminating the peritoneum (no peritubular leaks) due to a complete extraperitoneal route for the transligamentary variant, absence of biliary or peritoneal septic complications, easy access for postoperative control or therapy, moreover it represents the sole possibility of stenting high derivations of hepatic ducts or of the convergence, singular-channeling or dual-channeling, and transtumoral drilling. In addition, it allows the possibility of long term or even permanent preservation and also drainage suppression is not followed by persistent drainage or external biliary fistulas.



Fig. 11 Axial drainage after choledocholithotomy. Low duodenal (D3) choledochal insertion

The disadvantages of common bile duct axial drainage refer to the set-up's relative technical difficulty, septic complications such as choleperitoneum or subphrenic abscess for the transparietohepatic variant, the accidental mobilization or dislocation of drainage tubes that may lead to reintervention, the drain presence may represent a failure factor of the common bile duct's transpapillary endoscopic deobstruction [27].

In common bile duct surgery the axial drainage must be analyzed as a stenting method for biliary-digestive anastomoses taking into consideration a series of aspects such as lesion type, common bile duct diameter, elements on which the method's indication are mainly based on, and secondly, the surgeon's preference for one procedure or another. Each type of drainage "has its own indications and value, arising precisely from respecting the indications. Enforcing the indications or usage in unindicted cases may compromise any method [11]."

The procedure's reliability must be analyzed taking into consideration a series of criteria: patient evolution (favorable or unfavorable); postoperative morbidity (fistulas, anastomotic unbinding, anastomotic stenoses, other associated pathology); postoperative mortality (recorded during admission or under 30 days from the date of the last intervention); survival (where this may be followed); comparative: axial stented biliary-digestive anastomoses compared to stenting through other methods (mainly with Kehr type drainage).

Method efficiency, the tradition and experience of the clinics where this study has been carried out, have imposed

axial drainage as a biliary decompression method in 80% of the cases; just in 5% of the cases it was used the Kehr type drainage, and in 15% of the cases the endoscopic oddian sphincterotomy. Due to the efficiency provided by the axial drainage, the preference for this method is obvious, and its usage in most cases is easily understood under these conditions also for stenting biliary-digestive anastomoses.

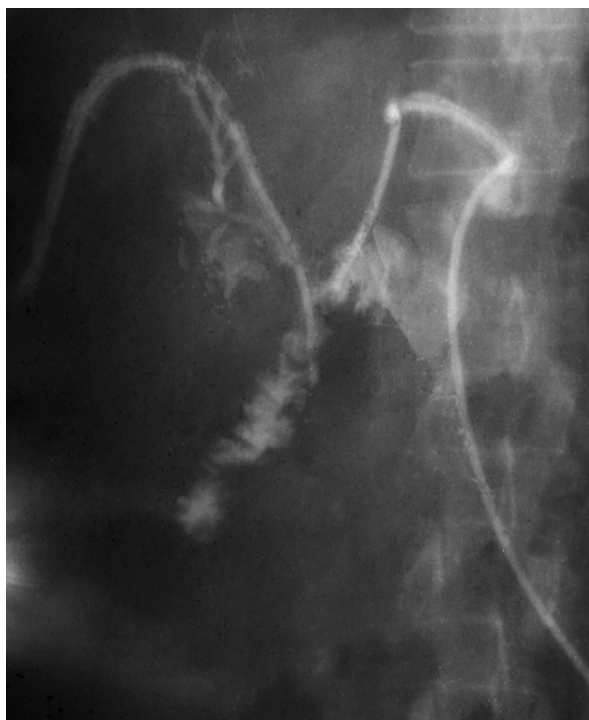


Fig. 12 Double axial stenting for a hepaticojunal anastomosis

In case of anastomoses performed for high lesions of the common bile duct, the axial drainage method is the election procedure, most of the times being the only possible stenting method of a difficult and precarious biliary-digestive anastomosis.

For the analyzed patients' group, the high common bile duct lesions have been mostly benign in nature, and the postoperative evolution has been favorable in most of the cases. The intrahepatic bile ducts presented an enlargement between 12 mm and 25 mm. The cases of postoperative mortality have been caused by associated pathology.

In biliary lithiasis, stenting biliary-digestive anastomoses through axial biliary drainage represents an alternative to other technical solutions, being comparable in results and efficiency. There were 231 cases of biliary lithiasis of the common bile duct that benefited from biliary-digestive anastomoses stented through axial drainage, 130 being common bile duct-duodenal anastomoses stented through axial biliary drainage exteriorized in a transligamentary manner in 80% of the cases and transhepatoparietal in 20% of the cases. The diameter of the common bile duct varied between 12 mm and 25 mm. The evolution has been favorable, with no specific postoperative morbidity or mortality being recorded. The jaundice remission

dynamics was fast (days 4-7 postoperative) and average (8-10 days).

The surgical procedures used were the "Roux-en-Y" hepaticojejunostomy stented by biliary axial drainage, in some of the cases a double stenting was performed (with right transhepatoparietal and left transligamentary exteriorization), in other cases axial stenting with transligamentary exteriorization was performed, and in other cases a segmented resection of biliary duct was performed, the anastomosis being "sutureless" - Brătucu procedure, with double stenting with transligamentary and right transhepatoparietal exteriorization. Axial drainage was not used in cases where it was strictly counter-indicated or technically impossible to perform.

Of the total of 309 biliary-digestive anastomoses stented through axial biliary drainage, 297 cases had a favorable evolution. The high percentage of good results recommends stenting through axial drainage of biliary-digestive anastomoses as an efficient, safe, viable method ensuring evolution guarantee without anastomotic fistula.

As a stenting method of biliary-digestive anastomoses, the axial drainage has proven its benefits, the results being clearly favorable for high bile duct lesions, precarious biliary-digestive anastomoses [29], in iatrogenic lesion corrective biliary-digestive anastomoses or in completion of transtumoral drilling.

Biliary-digestive anastomoses stented through axial drainage have good and very good results in lesions for which their indication is recommended (biliary lithiasis, dysfunctional biliary-digestive anastomoses, bile duct neoplasms, extrinsic or intrinsic malignant or benign stenoses, other than lithiasis, of the common bile duct, bile duct malformations) [61]. These results are comparable or even superior to other alternative solutions, especially when axial biliary drainage is exteriorized in an extraperitoneal manner (transomphalic or transligamentary). The superior results of stenting biliary-digestive anastomoses through axial drainage compared with the absence of drainage or Kehr type drainage resides from the practically unlimited possibility to apply it to any type of biliary-digestive anastomosis in the common bile duct axis, as well as from its advantages, corroborated with the disadvantages of Kehr drainage (choleperitoneum, persistent biliary fistula, late secondary biliary stenoses, peritubular bile leaks, retention in the common bile duct, drain rupture, accidental suppression, impossibility of extraction and prolonged placement).

VI. CONCLUSIONS

Axial type drainages allow in essence a choledochorrhaphy per primam, advantage which transcystic or Kehr drainages do not provide.

Axial drainage represents a safe method with very good results along a series of interventions within the biliary area. As a stenting procedure for biliary-digestive anastomoses it is an election method in all types of biliary-digestive anastomoses (common bile duct-duodenal and common bile duct-jejunal) and the only alternative in case of high biliary-digestive anastomoses. Removal of the axial drainage tube does not present the risk of persistent drainage. The method is

indicated to be used as a safety supplement in the immediate postoperative protection of biliary-digestive anastomoses and choledochorrahaphies. Except for the method's counter indications, axial drainage has proven its superiority compared to other stenting methods through a series of undisputed advantages.

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