Closure of the Common Duct -Endonasobiliary Drainage Tubes vs. T Tube: A Comparative Study

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Abstract For the last century T tube drainage of the bile duct has remained standard practice following choledocholithotomy. It vents the biliary tree, provides route for cholangiography and management of residual stones. However, T tubes are associated with significant complications. This retrospective study compared the use of Endonasobiliary drainage tubes and the T tube in 66 patients who underwent open choledocholithotomy for effectiveness and complications. Both groups were statistically comparable. Only 15.15% patients in the Endonasobiliary drainage group, while 45.45% patients in the T tube group developed complications. Severe complications such as biliary peritonitis and intraperitoneal collections were noted only in the T tube group. The Endonasobiliary drainage tube was removed significantly earlier and patients from this group were discharged earlier as compared to those in the T tube. The Endonasobiliary drainage tube is as effective as the T tube in postoperative biliary drainage and allows cholangiograms to be performed. Its use is associated with less complications and it can be removed safely earlier than the T tube. Thus patients have a shorter time with tubes and can be discharged home earlier.

Keywords Choledocholithotomy · T tube · Endonasobiliary drainage tube · Choledocholithiasis · Cholangiogram

Introduction

In 1889 Robert Abbe of New York performed the first documented successful choledocholithotomy in a 36 year old woman who was almost “black-green” with jaundice [1]. However the credit for popularizing choledochotomy as a routine procedure belongs to Hans Kehr of Halberstadt and Berlin. He introduced the T tube for intraductal drainage which is still in use today [2]. One of the reasons for drainage of the duct was ampullary oedema that resulted from forced ampullary dilatation with bougies, which was routinely practised decades ago. This instrumentation is no longer routinely needed and therefore many consider primary closure of the duct without intraductal drainage as a safe procedure. However drainage of the common bile duct using a T tube has been standard practice following choledochotomy for choledocholithiasis [3]. The T tube vents the biliary tree and prevents extravasation of bile through the choledochotomy incision in the immediate postoperative period. It allows a post operative cholangiography and forms a route for the management of residual stones. The T tube is however associated with possible complications which may at times be serious, besides prolonging the hospital stay [4–11].

Many authors have successfully promoted primary closure of the common bile duct (CBD) without intraductal drainage with no significant serious morbidity [12–21]. Others have used alternative methods but maintained the principle of biliary drainage by using retrograde trans-hepatic biliary drainage (RTBD) [22–24] or transcystic tube drainage (C tube) [22].

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We have previously reported the advantages of the use of endonasobiliary (ENBD) tubes as a means of postoperative CBD drainage [25] and this technique has also been subsequently applied to laparoscopic Choledocholithotomy [26]. In the present study we compared the results of intraductal drainage through ENBD tubes with the standard T tube, a comparison which has not been reported in literature.

Material and Method

In this retrospective study conducted in the department of General Surgery Sheri Kashmir Institute of Medical Sciences Srinagar (India) between January 2002 and December 2006, 33 patients underwent Choledocholithotomy with primary closure of the CBD over endonasobiliary drainage tubes. These patients were referred for surgery after failed attempts at Endoscopic retrieval of the stones. As per routine these patients had a 7 fr PVC endonasobiliary drainage tube (modern industries, India) placed in the CBD at the time of ERCP. Prior to surgery all the patients were evaluated with routine investigations including blood counts, liver function tests and Coagulograms. An ENBD tube cholangiogram was performed on all the patients before they were taken for elective open surgery to confirm findings and delineate anatomy. The C.B.D was opened through a standard supraduodenal anterior choledochotomy, stones removed and saline flushes given. A flexible choledochoscope was passed as far as the ampulla distally and up the right and left hepatic ducts proximally to ensure clearance of the biliary tract from any residual stones. The already placed ENBD catheter was then flushed with saline to confirm patency and was repositioned in the CBD. The choledochotomy was then closed back with 3/0 vicryl (Ethicon) continuous sutures. A subhepatic drain was kept and the abdomen closed back in layers. Post-operative cholangiogram through the ENBD tube were performed as per routine between the 6th–8th postoperative day to image the biliary tree and demonstrate residual stones if any. The intraductal drains were then removed and the patients discharged. The subhepatic drains were removed in all by the 2nd postoperative day as in the T tube group.

From records available in the department, 33 most recent patients who had undergone choledocholithotomy with T tube drainage were taken as the control group. These patients also had undergone prior failed attempts at endoscopic stone removal and had been referred for surgery with ENBD in place. This group of patients all had supraduodenal choledochotomy followed by removal of stones and confirmation of clearance by choledochoscopy. The ENBD tube had been removed and the CBD closed over a 12–14 fr T tube (Kehr type, PVC, Romson, India) using interrupted 3/0 vicryl (Ethicon). Post operatively all patients

had T tube cholangiograms prior to removal of the tube. All the patients without ENBD tubes, not operated electively or those with associated disease of the CBD such strictures and neoplastic lesions besides choledocholithiasis were excluded.

The records of the two groups of patients, one having T tube placed after choledocholithotomy and the other with ENBD tubes were compared and analyzed statistically.

Results

Both the groups were comparable for various clinical parameters and investigations except for respiratory rate and urea levels (Table 1). Female sex was predominantly involved in both the groups, 59% vs 82% for ENBD vs T tube group respectively. There was no significant difference in the size of the CBD at the time of surgery (Table 1). 54.5% of the patients in the T tube group had multiple stones in the CBD, with 18 % having stones removed also from the intrahepatic ducts. In the ENBD group multiple stones were found in 59.09% and intrahepatic stones in 14 %. Two patients in both groups had dead worms in the CBD in addition to stones. The ENBD tubes were tolerated well by all patients except one, who pulled out her tube on the 4th postoperative day.

Morbidity encountered in both groups is shown in Table 2. Six patients in the T tube group developed wound infection as documented by pus drained from the incision site while only three developed this complication in the ENBD group. Respiratory infections requiring additional treatment were noted in four patients with T tubes and in two with ENBD tube. However, this had no relation to the method of drainage used. Only one patient developed biliary peritonitis during the course of this study. This patient had undergone closure of the CBD over a T tube and developed the complication at the time of removal of the T tube. The leak from the CBD was managed by endoscopic stenting and antibiotics. Two patients who developed severe pain after removal of intraductal drains were noted to have intraperitoneal collections in Morrison's pouch as documented radiological studies. Both belonged to the T tube group. These two patients were managed conservatively and no intervention was needed. No patient in the study developed cholangitis. Although not related to the method of drainage, postoperatively one patient had a retained stone and one had a worm both in the T tube groups, which were demonstrated on the T tube cholangiogram. These patients were managed successfully by ERCP. Of the 33 patients who had undergone ENBD closure postoperative cholangiograms could not be performed in four patients. In three the ENBD was noted to have slipped out of the CBD and its end was demonstrated to lie in the duodenum at the time of attempted cholangiogram. The other had removed the ENBD tube herself on the fourth day before a cholangiogram could

Table 1 Clinical parameters and investigations

Variable	ENBD Closure (n=33) Mean±SD	T Tube Closure (n=33) Mean±SD	Student t (2 tail)	Sig (p<.050)
Age	49.000±15.656	47.000±11.795	0.556	0.582 NS
Pulse	85.030±10.408	84.455±5.863	0.300	0.766 NS
SBP	120.909±10.417	128.181±17.221	-1.979	0.056 NS
RR	14.121±1.268	14.909±1.588	-2.250	0.031 S
Temp	98.775±0.761	98.545±0.665	1.532	0.135 NS
Hb	11.687 ±1.922	10.967±1.406	1.981	0.560 NS
TLC (x10 ⁹)	7.594 ±3.110	7.245±4.370	0.391	0.699 NS
Neut (%)	66.939±14.530	73.181 ±14.129	-2.007	0.053 NS
Platelet	206.333±64.988	242.636±91.583	-1.945	0.061 NS
Bil	5.104±6.288	6.875±7.014	-1.041	0.306 NS
ALP	891.845 ±774.809	741.636±251.151	1.148	0.260 NS
SGOT	75.333±54.504	70.878±61.160	0.335	0.740 NS
SGPT	66.424±± 32.149	66.818 ±39.288	-0.047	0.963 NS
Albumin	3.751±0.895	3.630 ±0.338	0.684	0.499 NS
Urea	37.818±8.589	49.545 ±26.37	-2.323	0.027 S
Creat	0.949 ±0.267	1.156±0.711	-1.475	0.150 NS
INR	1.221 ±0.120	1.200 ±0.122	0.674	0.505 NS
CBD size	1.497±0.439	1.518±0.355	-2.06	0.838 NS

be performed. All these patients had normal liver functions and sonograms and were discharged without complications.

Post operative comparisons of liver functions in the two groups showed no significant difference (Table 3). The ENBD tubes were removed in all by the 8th day. In comparison, the T tube was not removed till the 12 day in 80% of patients. This variation was statistically significant $p<.05$ (Table 3). On average the patients in the ENBD group were discharged earlier than those in the T tube group, the difference was found to be significant (Table 3).

Discussion

First line of treatment of common bile duct stones is Endoscopic removal. However, common bile duct exploration (CBDE) is still a common procedure where ERCP

fails, especially in our part of the world where the stone size and burden is large. Post operative common bile duct drainage is still preferred by many surgeons and has definitive advantages. The intraductal drains decrease intraductal pressure by draining bile till oedema resolves and the choledochotomy heals thus preventing bile leaks [25]. T tubes have the distinction of being the standard for intraductal drainage for the last century now. Cholangiography can be performed through them, missed stones identified, dissolution therapy using drugs administered and even stones retrieved via their tract [27]. Complications are known to be associated with the use of T tubes. These may be displacement, biliary sepsis, thromboembolism, electrolyte and fluid losses, wound infections, pancreatitis and obstructive jaundice [1–6]. Biliary leaks have been shown to occur at the time of tube removal or at cholangiography [8] which may progress to intraperitoneal collections, external fistulae or even peritonitis [9–11]. The CBD may even be traumatized at the time of removal [13] with possible fibrosis and stricture.

In our study the two groups were comparable prior to surgery with respect to clinical profile and CBD size (Table 1). The overall incidence of ERCP complications in our institute is 6% however none of the patients in the study suffered any ERCP procedural complication. Postoperatively the bilirubin, alkaline phosphatase and liver enzymes were also not significantly different meaning that the ENBD tube is as effective as the T tube (Table 3). However, complications were found to be less in the ENBD group (Table 2). Respiratory tract infection and wound

Table 2 Complications

Complication	ENBD group (n=33)	T tube group (n=33)
Wound infection	3(9.09%)	6(18.18%)
Intraperitoneal collection	0	2(6.06%)
Biliary peritonitis	0	1(3.03%)
Retained calculi	0	1(3.03%)
Biliary ascariasis	0	1(3.03%)
Respiratory tract infection	2(6.06%)	4(12.12%)
Total	5 (15.15%)	15(45.45%)

Table 3 Post operative comparisons in two groups

Variable	ENBD Closure (n=33) Mean±SD	T Tube Closure (n=33) Mean±SD	Student t (2 tail)	Sig (p<.050)
Billirubin(mg/dL)	2.690±3.606	3.349 ±2.500	-0.814	0.421 NS
ALP(U/ L)	531.454±206.042	478.106±184.505	1.015	0.318 NS
Albumin(gm/dL)	3.100±0.536	3.130±0.508	-0.342	0.735 NS
SGOT(U/ L)	50.878±27.219	50.575±19.981	0.070	0.945 NS
SGPT(U/ L)	56.333±27.380	59.848±21.870	-0.608	0.547 NS
Removal ENBD/T tube(days)	6.515±0.905	11.727±1.536	-16.489	0.000 S
Post-op Stay(days)	8.303 ±1.629	13.227±1.654	-12.199	0.000 S

infection in the T tube group was twice that noted in the ENBD group. Greater incidence of infective complications have been noted to be associated with the use of T tubes in previous studies also [5]. In our study the ENBD was removed 6.515 ± 0.905 days post insertion which is almost 5 days earlier than the T tube (11.727 ± 1.536). This means overall less discomfort by the tube and subsequently earlier discharge. More importantly, in the ENBD group no serious complication was noted at removal such as an intraperitoneal collection or biliary peritonitis. Where as, the overall incidence of complications related to T tube removal was 9 %. Two of these patients had intraperitoneal collections and the other biliary peritonitis. Bile leaks following removal of the T tube are well documented in literature and although many reasons have been elaborated to try to explain them including choice of material [9, 29, 30] shape of the T tube [9, 31] suture material, [10, 28, 33, 34] surgical technique [35] and the time of removal [11, 36] no consistent opinion has been found to hold true in all studies. Thus the actual cause still probably remains elusive. In 1965 Winstone et al, noted a 4% bile leak rate following use of PVC T tubes in 100 patients operated for choledocholithiasis. They blamed the PVC material for the leaks, which was thought to be more inert. PVC hardens when it comes into contact with bile [9, 29] and this further traumatizes the CBD at time of removal. For this reason latex T tubes were recommended however in 1971 Osborn thought latex washed with silicone to be the responsible for 3 cases of leak in his study [30]. Latex is also inert and does not induce much reaction therefore its removal may have to be delayed till at least three weeks. Horgan et al, also reported bile leak with the use of latex T tubes [37]. These leaks due to inert T tube material may be reduced by use of natural rubber T tubes. Gillat and colleagues study on 36 patients, performed cholangiograms a week after insertion of the T tube [11]. They removed the tube immediately after normal cholangiograms. 7 patients (19%) had an intraperitoneal leak and one of these required a laparotomy. The study by Gharaibeh in 2000 demonstrated a bile leak in 7.2% (7/97) of patients after T tube removal [8]. Three of

these required laparotomy (of which one died) and the rest were managed conservatively. Radiologically documented leak was demonstrated by Domellof and colleagues [31]. In their study 51 patients had there T tubes removed under flourescopic imaging 5-13 days post-insertion and found bile leak in 25 (49%) patients. A similar result (50% radiological leak) and 7% biliary peritonitis was obtained by Mosley et al in his study [38]. Literature is full of reports of bile leaks occurring at the time of T tube removal [27, 30, 33, 37, 39, 40] In the ENBD group there is no opening in the CBD and no chance of trauma to the wall at the time of its removal, therefore there is almost no reason for a bile leak. Even if the ENBD gets displaced early as happened in three of our patients, or is removed early as was the case in one of the patients no leak occurs. In comparison if the T tube gets displaced early or is inadvertently removed before time, bile leak or biliary peritonitis is inevitable usually requiring a laparotomy. Thus we believe the ENBD is easier and safer to remove than the T tube.

There is a trend not to send patients home before removal of all tubes in our department. This is in contradiction to the practice of other surgeons who discharge patients along with tubes or drains [20] and follow them with cholangiograms in the out patient department. Our patients are usually illiterate, from distant areas with poor sanitation and limited medical resources. Therefore we prefer to keep them in hospital and not entrust them with the care of T tubes. This prolongs the hospital stay but we believe it is a small price to pay for patient's safety. Therefore patients with ENBD tubes were discharged almost 5 days earlier than those with T tubes, which is a significant advantage.

To avoid the complications of T tubes and reduce hospital stay many surgeons perform primary closure without T tubes with appreciable success [16, 18–20]. However there is still a risk of bile leak and postoperative cholangiography cannot be performed. In the recent study conducted by Yamazaki and colleagues (2006) the postoperative hospital stay in the primary closure group was reported at 18.3 days [41]. In a study by De Roover and

colleagues (1989) the postoperative hospital stay was 12 days in the primary closure group [18]. These are significantly more than the postoperative stay noted with ENBD closure in our study. In 1994 Williams and colleagues demonstrated a shorter postoperative hospital stay of 8 days in the primary closure group [3]. However, they reported 13 patients of the 37 who had undergone primary closure to drain bile through the wound drain for a median of 5 days (2–7 days). Seale and colleagues on average discharged patients 3.6 (0–7) days after primary closure of the CBD following choledochotomy [20]. However, patients in his study were discharged home along with their drains which were removed 3 to 10 days postinsertion. The duration of bile drainage from the drains was not mentioned.

Drainage of the CBD has been achieved via the cystic duct (C tube) [22, 44, 45]. C tubes preserve the advantages of T tube in the form of cholangiography and percutaneous management of retained stones if needed. We have no personal experience with the use of these tubes, but in the study by Hotta et al, the average removal of the C tube was 16.4 ± 3.5 days [22]. This is similar to results of other studies using C tubes [43, 44]. However, it is significantly more than with the ENBD tube (6.515 ± 0.905) as described in this study. This difference is likely to allow tract maturation before C tube removal can be attempted. Similarly the postoperative stay in Hotta's [22] study was 22.4 ± 4.6 days which again is much more than that found with ENBD tubes (8.303 ± 1.629).

Primary closure over retrograde transhepatic biliary drains (RTBD) placed intra or extraperitoneally has also been used for duct drainage following CBDE [22–24]. They have been shown to be effective in draining the biliary tree in the postoperative period and are also amenable to cholangiography and percutaneous techniques of stone retrieval. We are skeptical that they may be associated with unwarranted trauma to intrahepatic ducts, bleeding into the biliary tree and at the liver surface and as such do not use them. In the study by Hotta [22], the RTBD tubes were removed on 22 ± 5.8 days post insertion and the postoperative hospital stay was 29.5 ± 5.8 days both being longer in contrast to ENBD closure.

Primary closure of the CBD over biliary endoprosthesis has also been recently performed with the advantage of shorter hospital stay [45]. Cholangiography again is not possible and endoscopy has to be performed to remove the stents after 4 weeks, which means an additional procedure that may add to the morbidity.

Conclusions

In this comparative study we found the use of an endonasobiliary drainage tube has definite advantages over

the T tube. It achieves effective decompression of the biliary tree in the immediate postoperative period, is easy to manage and safe to remove. Cholangiograms can be performed at any time preoperatively or postoperatively after placement. The patients are already accustomed to the tubes preoperatively and tolerate them as well in the postoperative period. Risks of bile leak and related complications associated with the removal of the T tube can be avoided. There is no need to wait for tract maturation to take place before the tube can be safely removed without complications. This means the patient stays with intraductal drainage for a significantly shorter period and therefore has a shorter postoperative hospital stay.

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