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Original Article

The experiences of surgical treatment on a case with HCC invasion of the right diaphragm

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Abstract: Objective: To explore the indications, surgical method, and matters needing attention of partial right diaphragma resection, and to summarize the experience of surgical therapy for liver cancer with right diaphragm invasion. Methods: The clinical data of 27 patients with liver cancer which invaded diaphragma underwent partial right diaphragma resection and hepatectomy in our hospital from September 2008 to September 2012 were retrospectively analyzed. Results: All patients were performed successfully. Tumor diameter ranged from 5.0 to 15.0 cm (average 8.5 cm). Area of right diaphragma which were resected ranged from 9.0 to 50.0 cm^2 (average 28.5 cm^2). Operation time was 110~250 min (an average of 165 min). Blood loss was 450~2600 ml (an average of 870 ml). 9 cases (33.3%) were confirmed for diaphragma invasion by postoperative pathology. All the cases suffered a small quantity of right thoracic effusion postoperation, other complications including chronic hepatic insufficiency in 4 cases and early postoperative bleeding, upper gastrointestinal bleeding, biliary fistula, under the diaphragm infection in 1 case. All the cases recovered after treatment. There was no perioperative death. 19 patients have undergone postoperative comprehensive treatment. 6 patients refused to treat. 2 cases lost to follow-up. The 0.5-, 1-, 2-, and 3-year survival rates after operation were 92.6%, 81.5%, 51.9% and 33.3% respectively. Conclusions: Right diaphragma invasion is not contraindication of hepatectomy. Right diaphragma resection is safe and feasible, and forward curative effect is satisfactory.

Keywords: Carcinoma, liver, partial diaphragma resection, diaphragmatic invasion, surgery

Introduction

Currently, the preferred method for the treatment of hepatic carcinoma is surgical operation. But the question is whether it's suitable to choose the path of surgical operation when hepatocellular carcinoma cells invade the diaphragm? What about the security and the therapeutic effects of surgical operation? What should we pay special attention to? Unfortunately, so far there are still no research results on the topic in foreign and domestic literature. The article has got a preliminary summary on the microtome experience of the cases with HCC invasion of the right diaphragm afforded by clinical experience based on 27 cases.

Materials and methods

Clinical material

20 male patients and 7 female patients were included in the study. With ages from 34-71, and the average age of them was 52.3 years of age. There were 23 patients with primary liver cancer and 4 patients with metastatic hepatic carcinoma which primary lesion are separately derive from one case with stomach carcinoma,

one case with colon carcinoma, one case with rectal carcinoma and one case with breast carcinoma. There are 5 patients whose tumors are Located in the VII section, 3 are located in the VIII section, 13 are located in the VII and VIII section, 4 are located in the VI, VII and VIII section, 2 are located in the V, VI, VII and VIII section. The diameter of tumors is 5.0~15.0 cm, the average diameter of them is 8.5 cm. All the grades of preoperative liver function are children. The surgery and the pro-operative pathological diagnosis showed 16 cases were accompanied by liver cirrhosis. All the patients who have accepted radiography examination of Chest pa & lat have no (front and lateral chest radiographs) r-pectoral hydrops.

The methods of surgery

We take the conventional methods such as trachea cannula and intravenous general anaesthesia, and the patient lies down in a horizontal position. Then we put a gauze bag behind the right costal arch and iliac crest (elevating the right edge of the patient's body up 30 degrees). Then we cut an oblique incision below the right costal margin (xiphoid appendix ⟷ posterior axillary line). Then we use an automatic liver retractor with suspension type to strongly retract the right upper abdomen from the right rear, so we can fully reveal the upper abdomen (especially the dome of the right liver, see **Figure 1A**). Then we slip an infantile urinary catheter into the ligamentum hepatoduodenal to block liver blood flow when patients are complicated by massive haemorrhage. Extensively dissect the ligament around the right liver (to the area which is invaded by tumor and the areas which have the right diaphragm invaded by HCC). Then fill in the yarn piece below, behind and nearby the right hepar, thus we can reveal a large part of the right hepar. Then the anaesthetist raises the patient's head to the highest position. At this time, we can remove the diaphragm invaded by HCC completely to a position at least 1.0 cm away from the edges of the area which has been invaded by the tumor (**Figure 1B-D**). Then block up the holes of the diaphragm temporarily by using a big piece of yarn. At this time, the top of the right liver has been extensively dissected, and then we fill in the yarn behind the right liver so that the whole liver can be further revealed. At a position at least 1.0 cm~2.0 cm away from the tumor, we use the fulguration technique to cauterise the liver capsule and then draw a line in order to do hepatectomy surgery. Then we gradually separate and ligature the blood channel leading to the lesion side (**Figure 1E**). We cut down the liver by using the electrotome and ultrasound knife until we completely remove the whole specimen. Then we should swiftly stop the bleeding of the liver trauma and make a temporary suture (**Figure 1F**). During the process of cutting the liver, too much intraoperative bleeding has blocked the blood flow into the liver approximately 5-12 min in 18 cases. Then, we should take out all the gauze around the liver; first, we wash and soak the abdomen twice by using warm distilled water, then take out the big gauze which is used to block up the hole of the diaphragm. Then we wash and soak the abdomen and the right pleural cavity twice by using warm distilled water at the same time. After they have definitely absorbed the distilled water, we get material separately from the area which lies around the liver and the diaphragm and send them to be checked. Lift both sides of the diaphragm by using the haemostatic forceps (**Figure 1G**). Then we use strings with the size of 7 to gradually suture and knot the pleural cavity from two sides to the central position so that we can narrow the diaphragm gap. We don't know the last needle in the central position. Then we should insert a urine tube of size of 12 into the pleural cavity at the point we plan to tie a knot (**Figure 1H**). Slowly tighten the stitches and fix the rubber tube, pump out the pneumatics in the right pleural cavity by using negative-pressure devices, then tell the anesthetist to fill their lungs twice or three times slowly, and then remove the catheter after the last time we pump out the pneumatics, my assistant then helps tighten the stitches and tie a knot. If we find that there is no active bleeding in the liver lesion and right inferior phrenic artery, (**Figure 1I**) then we can put latex tubing in the surgery field, and make the abdominal incisional closure in layers in the usual manner. Finally, cut down the specimen to be sent for pathological diagnosis (**Figure 1J**).

Results

The results of the surgery

All the surgeries were successful. The time we use during the process of operating surgery is 110-250 min, the average time of them is 165

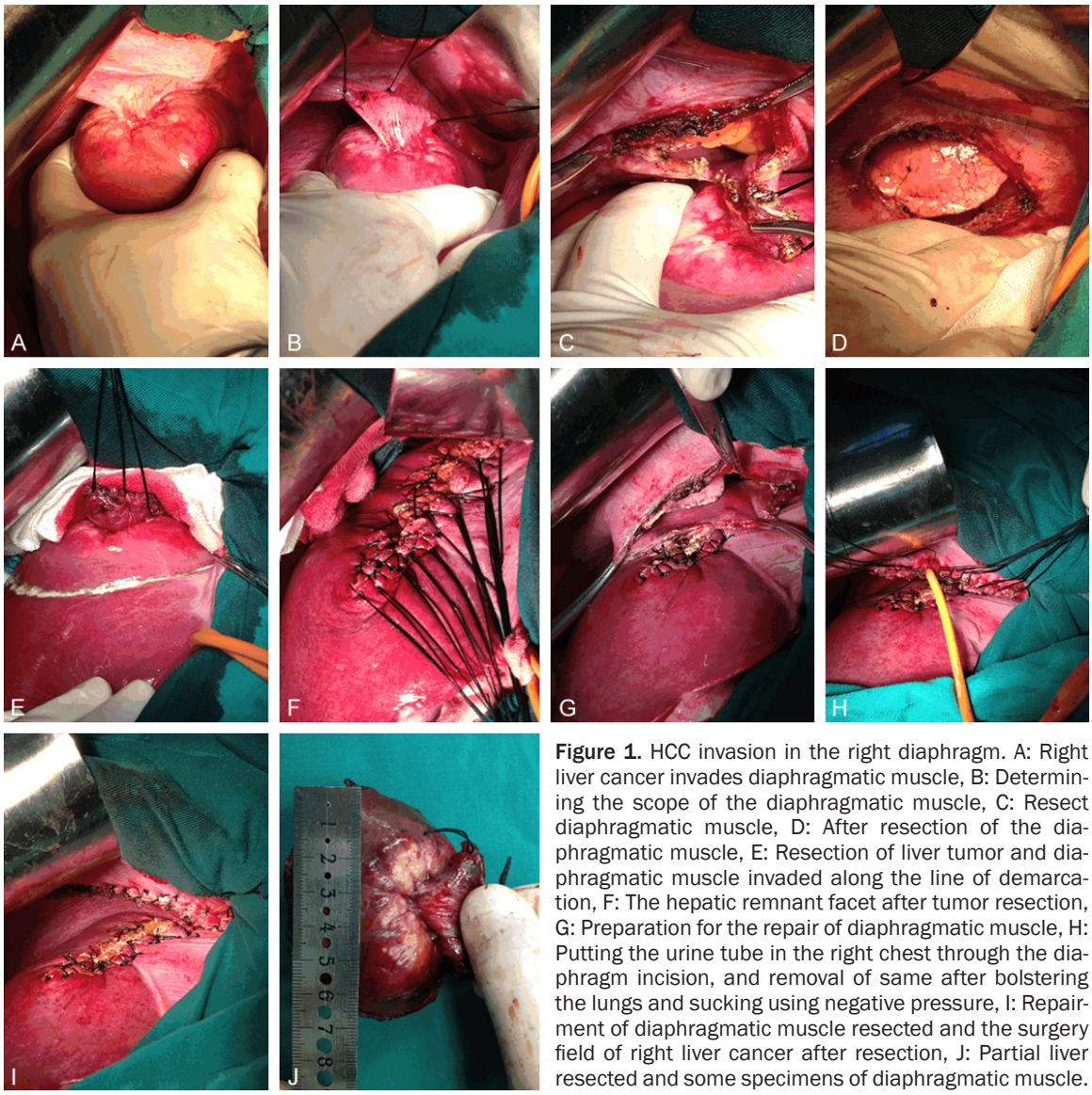

Figure 1. HCC invasion in the right diaphragm. A: Right liver cancer invades diaphragmatic muscle, B: Determining the scope of the diaphragmatic muscle, C: Resect diaphragmatic muscle, D: After resection of the diaphragmatic muscle, E: Resection of liver tumor and diaphragmatic muscle invaded along the line of demarcation, F: The hepatic remnant facet after tumor resection, G: Preparation for the repair of diaphragmatic muscle, H: Putting the urine tube in the right chest through the diaphragm incision, and removal of same after bolstering the lungs and sucking using negative pressure, I: Repairment of diaphragmatic muscle resected and the surgery field of right liver cancer after resection, J: Partial liver resected and some specimens of diaphragmatic muscle.

min. The bleeding volume in the operation is 450~2600 ml, and the average bleeding volume is 875 ml.

Postoperative pathological analysis

The postoperative pathological analysis shows that there are 23 patients with primary hepatocellular carcinoma (they are all patients with HCC), 4 patients with metastatic adenocarcinoma, and their livers and Diaphragm edges are negative, and 9 patients are proved to be patients with diaphragms invaded by liver cancer.

The recovery condition after operation

There are 4 patients who have the occurrence of hepatic decompensation after surgery, one patient has a bleeding infection, one has gastrointestinal haemorrhage, one has biliary fistula and one has sub phrenic infection, and all these symptoms are caused by coagulation dysfunction during the early period of post operation. They have recovered after accepted conservative treatment. Some pneumatics occurred in the right pleural cavity of all patients, but we didn't manage this specially. All the patients walked out the hospital healthy 9-59 days after the surgery, and there were no fatalities during surgery itself.

The circumstance of the surgical treatment and follow-up visit

There are 19 patients accepting treatment after surgery (including chemotherapy, inter-

vention and biological therapy), there are 6 patients refusing to accept treatment, and 2 patients lost after failing to follow up treatment after accepted surgery. The survival rate of 6 months after surgery is 92.6%, 1 year after surgery is 81.5%, 2 years after surgery is 51.9%, 3 years after surgery is 33.3% [1].

Discussion results

The tumor always makes the diaphragm suffer when the cancer finally grows big in the right hepatic superficial part because a large part of the right liver is covered by the diaphragm, so dealing with the diaphragm invaded by BCC is a very tricky business. So it is very important and necessary for us to discuss what the most effective and safe way to deal with a diaphragm invaded by BCC.

According to the merotomy experience of the cases with HCC invasion of the right diaphragm afforded by clinical experience based on 27 cases, we can know that all the surgery is successful and all the patients leave hospital healthy, and no severe thoracic complications occurred in patients, and the survival rate 6 months after surgery is 92.6%, 1 year after surgery is 81.5%, 2 years after surgery is 51.9%, 3 years after surgery is 33.3%. Our experience and observation is as follows:

1. It's difficult to judge accurately if BCC has invaded into the right diaphragm before the surgery or during the operation: we can just find that there is a tumor on the top of the right liver in the right diaphragm through the upper abdominal CT and MRI examination before the operation, and we can't know if the right diaphragm has really been invaded by a tumor. At the same time, we can just preliminarily observe that BCC has a close relationship with the right diaphragm through exploratory laparotomy. On the one hand, we can regard this kind of close relationship as invasion; on the other hand, we can also see it as a kind of adhesion. In the report of Chenqian, we can know that there are 9 patients of the 13 cases were diagnosed as diaphragm involvement, and 9 patients of the 27 cases were diagnosed as diaphragm invasion. If we want to judge accurately if BCC has invaded into the right diaphragm, we must rely on pathological diagnosis. If it's really diaphragm invasion, we can cure the patient only by removing the diaphragm invaded by the tumor, but if the diaphragm is wrongly judged to be adhesion, there will be residual tumor existing in the liver [2]; if the relationship between the BCC and diaphragm is a kind of adhesion, tumor spreading and fatal bleeding will appear because of the tumor breaking during the process of isolation, and it's difficult to avoid the existence of tumor residual after we have removed the liver tumor, so my advice is to remove all the tumor and the diaphragm involvement when the relationship between the BCC and diaphragm is either invasion or involvement.

2. Partial nephrectomy of the right diaphragm is an easy solution: remove the diaphragm directly along the edge of diaphragm involvement. Zhao Guodong [3], etc have hardly mentioned the problem of safe resection margin, Chenqian [4], etc chose the point 1.0 cm away from the outer edge of diaphragm invaded by tumor, and my finite pathological results favor Chenqian's idea. And my experience shows me that if we directly remove the diaphragm involvement in the first place instead of isolating the diaphragm involvement, this will not only make the top of right liver appear more easily, and can also help avoid the ulceration, spreading, residual and bleeding. That is to say partial cystectomy will make the tumor resection safer and more thorough. Hence, the diaphragm invasion should be a good indication rather than a contraindication to tumor resection, curative reception of the diaphragm invasion is possible, and patients must not give up treatment.

3. The problem of defect repair after the part of the right diaphragmatic muscle is resected: after the related part of the right diaphragmatic muscle is resected, directly collect the suture oppositely, if the defect area is larger, it can be a sutured closure from both ends to the centre. Zhao Guodong [3] and Chen Qian [4] are using line 3-0 spirit to closed suture continuously; the author adopts No. 7 silk to suture discontinuously. Before the closure of the last shot, putting the exhaust catheter of the drum lung is essential. After the closure of the diaphragmatic repair, the author does not implement closed drainage of the right chest the same as other researchers [4]. Of course, the authors believe that the specific repair method should be considered by the size of the diaphragm muscle defected and generally direct suture can be

closed to solve the problem [5]. Author have taken a patient whose defect area was 10 cm×5.0 cm directly suture oppositely from two ends to the centre, although tension is larger (the right diaphragmatic whose shape is a dome before almost becoming flat after repair), there were no chest complications after operation. In the literature, there are also reports which apply a polyester patch and pedicel greater retina to repair the old diaphragmatic rupture [6, 7]. The new method should also be used for the repair of the large area of diaphragm resected, but there is no report in the literature.

4. This problem regarding tumor spread of medical source cannot be ignored: The cancer cells fallen off can spread to the right side of the chest with improper protection measures after partial resection of the right diaphragm. Author's experiences include: ① Let the anaesthesiologist raise the surgical bed on the patient's head side to the highest possible before cutting the diaphragmatic muscle, to prevent blood mixed with the lost cancer cells from flowing into the right side of the chest when cutting the diaphragmatic muscle or resecting the part of the diaphragmatic muscle. ② Sealing the mouth of the hole with large pieces of gauze temporarily after resecting the part of the diaphragmatic muscle, to reduce the opportunities for blood flowing into the right side of the chest when resecting liver. ③ Do not crush the liver tumor when resecting liver as far as possible. ④ After resecting the liver tumor and stopping bleeding successfully, first, flushing abdominal cavity with distilled water twice, then taking out the large pieces of gauze sealing the mouth of the hole, and then flushing and soaking the abdominal cavity with distilled water twice. There is not a case occupied with right chest spreading in this group.

5. Positive postoperative comprehensive treatment is an important way to improve the overall efficacy of the treatment: the literature report [8-10] that the recurrence rate of five years after radical resection of large liver cancer is 80%. The tumors are large (average diameter of 8.5 cm), and there is an invasion of the diaphragmatic muscle (belong to T4). So, although both the liver and the diaphragm in this group are negative, it is also difficult to avoid recurrence after surgery. Therefore, it is necessary to treat comprehensively after the operation. The specific measures include hepatic arterial trans-catheter chemo-embolisation, through chemotherapy pump to the hepatic artery and portal vein dual perfusion chemotherapy, anti-HBV therapy, biology and targeted therapies etc., as well as closely postoperative monitored follow-up every 2~3 months on a regular basis. The measures of recurrent focal excision and radio frequency ablation should be taken when it is necessary. Based on the specific circumstances of each patient; an "individual" comprehensive treatment plan should flexibly be arranged in clinical work.

In a word, diaphragmatic muscle invasion is an indication, not a contraindication of radical resection of liver cancer, partial resection of liver cancer combined with right diaphragmatic muscle is simple and safe, and it is still available to obtain satisfactory long-term effect.

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Disclosure of conflict of interest

None.

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