

Thoracoabdominal approach in liver surgery: how, when, and why

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Abstract Liver resection can be performed with different surgical approaches whether abdominal or combined thoracoabdominal. This work focuses on the surgical technique for the thoracoabdominal approach in liver surgery, describing the technique, the rationale, and making a review of the current literature on such subject.

Keywords Liver surgery · Hepatectomy · Thoracoabdominal approach · Abdominal approach · Technique for liver resection

Introduction

Liver resection can be performed with different approaches. Accordingly with surgeons' experience, preference, and tradition the liver may indeed be approached with abdominal or with combined thoracoabdominal approach. This work focuses on the surgical technique for the thoracoabdominal approach in liver surgery, describing the technique, the rationale, and making a review of the current literature on such subject.

Technique

The patient is placed in the supine position with the arms perpendicular to the surgical bed. A midline incision is

made from the xiphoid process to approximately 4–5 cm above the umbilicus. Then, the incision curves laterally to the right hypocondrium along the 9th intercostal space up to the posterior axillary line (Fig. 1). In all patients the xiphoid process is fully exposed and removed, with the aim to gain about 3–5 cm of exposure just above the hepatocaval confluence. To enter into the right thoracic cavity, the insertions of the external oblique muscle and of the internal oblique muscle upon the costal arch are carefully detached in order to expose the costal arch around the 9th intercostal space (Fig. 2a). The bone cartilage of the costal arch is then removed, and the intercostal muscles are resected along the superior border of the 10th rib to avoid injuries of the neurovascular bundle, which runs along the inferior margin of the rib (Fig. 2b). Such resection of the intercostal muscles is prolonged posteriorly into the thoracic cavity with the aim to free that space preventing ribs fractures and bleeding during the retractor pulling. The diaphragm is divided for approximately 10 cm in the direction of the hepatocaval confluence until the surgeon's left hand could be easily inserted (Fig. 3). Attention must be paid to avoid injury of the phrenic nerve, which usually runs posteriorly and medially, and bleeding from the phrenic veins, which run in the direction of the right hepatic vein confluence [1]. At this point, the surgeon's left hand may be inserted in the thorax to handle and push out the liver (Fig. 4).

The closure of this incision starts from the thoracic wall. After the placement of a standard thoracic drain, single large absorbable sutures are placed between the two adjacent costal margins, and later tied. Then, the diaphragm is closed with a running suture that is placed starting from the internal and medial side up to the costal margin. At this time the single sutures in the thoracic wall are closed. Finally, the laparotomy is closed using standard techniques.

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Fig. 1 J-shape laparotomy (**a**). A midline incision is made from the xiphoid process to approximately 4–5 cm above the umbilicus. Then, the incision curves laterally to the right hypocondrium along the 9th intercostal space up to the posterior axillary line when the thoracoabdominal approach is selected (**b**)

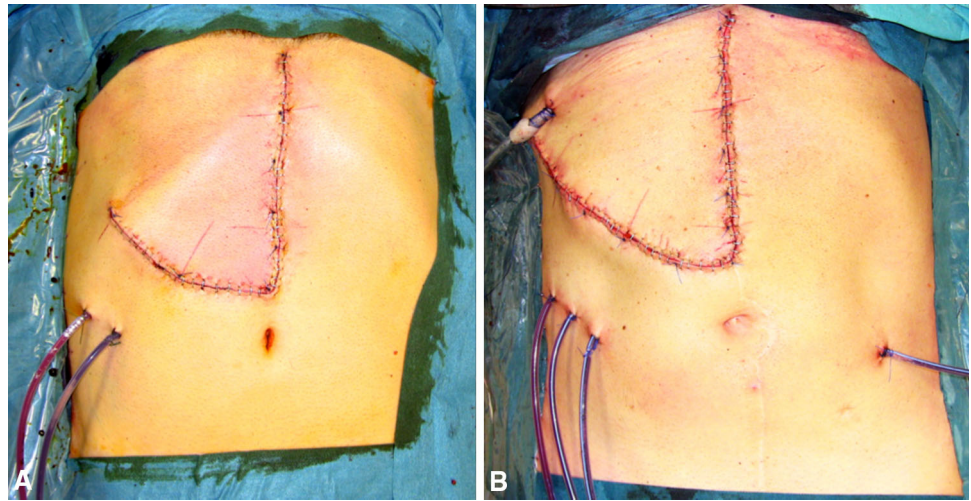


Fig. 2 Exposure and incision of the external and internal oblique muscle upon the costal arch around the 9th intercostal space (**a**). Removal of the bone cartilage (*arrow*) of the costal arch (**b**)

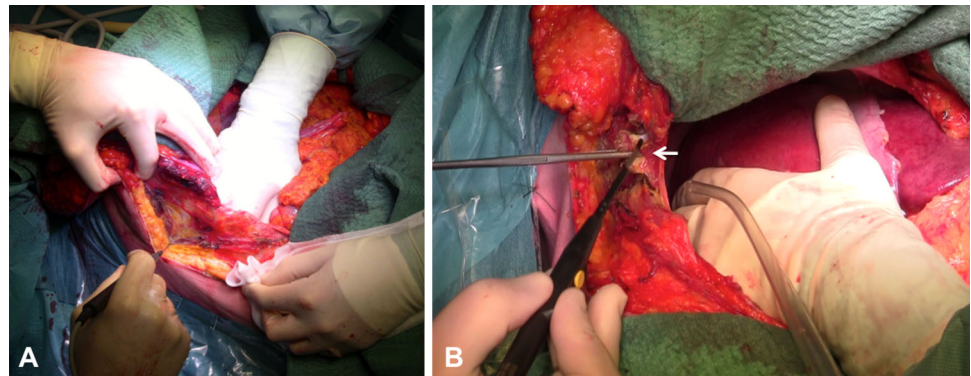
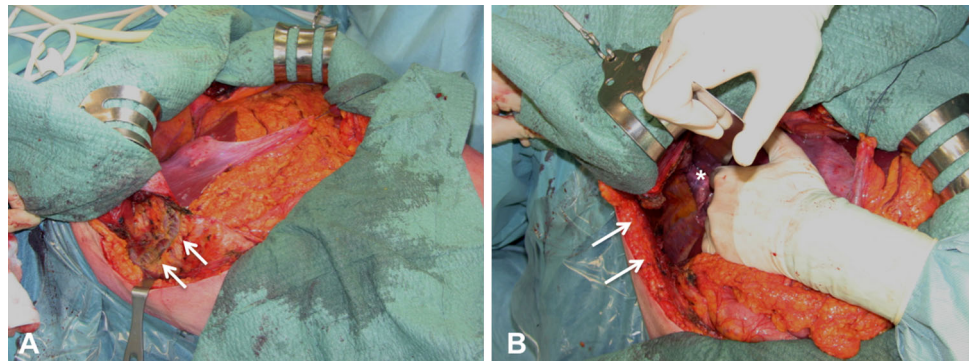


Fig. 3 Resection of the intercostal muscles (*arrows*) along the superior border of the 10th rib (**a**). Extension of the resection of internal muscles into the thoracic cavity (*arrows*) (**b**). The *asterisk* shows the right lung

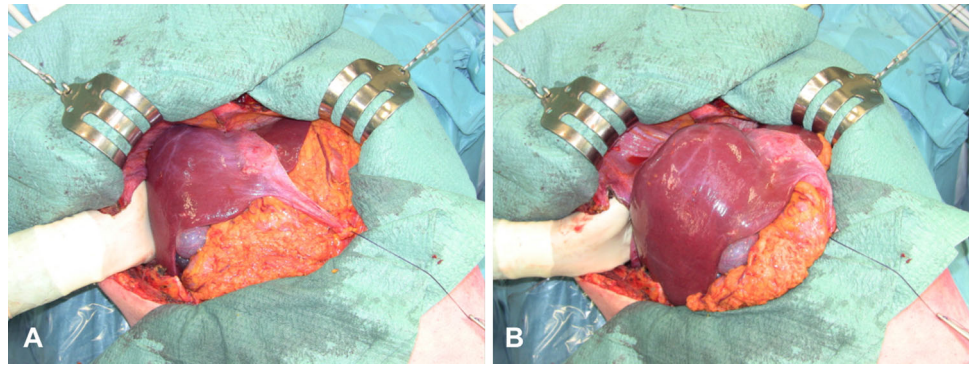


Rationale

The rationale for this incision is to allow better handling of the liver when liver dissection at the hepatocaval confluence or the paracaval portion is expected and a conservative approach is planned [2]. Indeed, this incision facilitates the liver handling using the surgeon's left hand, which provides an optimal vascular control, which becomes

crucial just at the end of the resection when the dissection is deeper and closer to the major vascular structures. Yet, this incision allows the operator having a frontal view of the paracaval portion, with the assistant hanging and tilting the liver upward and to the left, in that opening the space between the inferior vena cava (IVC) and the liver itself, and resulting in better view of the short hepatic vein to be ligated and divided.

Fig. 4 Positioning of the surgeon's left hand into the thorax to handle (a) and push out (b) the liver



Indications

This access should be used in patients with tumors involving segments 1, 4 superior, 7, and 8 close to the hepatic vein confluence into the IVC. In such cases, iatrogenic injuries of this area may be dramatic, especially if the exposure of the operative field is incomplete.

Another important indication for the thoracoabdominal approach is the patient with severe adhesions because of previous liver surgery as well as the patient with long and narrow thoracic cage. In both circumstances, the opening of the chest enlarges the field to safely operate the patients minimizing the risk of iatrogenic injury and giving eventually the chance to repair it.

Discussion

The thoracoabdominal approach in liver surgery has been mainly applied in Japan by different authors [3–10]. The herein reported technique is the one introduced by Makuuchi et al. [11], which is associated with the best short-term results ever reported for liver surgery. This fact should lead per se to consider the thoracoabdominal approach not just safe despite the apparent more invasivity but as one of the pivotal factors in liver surgery. Nevertheless, a specific work on this surgical technique has never been described, and we thought it is worthy to be written. It is a common opinion that the opening of the thorax in liver surgery increases the operative risks in terms of morbidity and mortality, while such maneuver is specifically performed to reduce such risks. The reported table shows the review of the literature on the subject (Table 1). Of note, each author had a different surgical approach in terms of thoracotomy and laparotomy performed. Thus, an effective comparison among different series seems difficult. However, all the authors showed good results without increases in morbidity or mortality using the thoracoabdominal approach. The study by Ko et al. [5] deserves mention being the only one randomized (Table 1). They compared the transabdominal

approach versus the transthoracic transdiaphragmatic approach for hepatectomy of segments VII and VIII in cirrhotic patients showing that the latter one was associated with better overall outcome.

As already mentioned, the frequency of the use of thoracoabdominal approach depends on the surgeon's preference, even though in some specific circumstances we believe it should be always considered. Based on our experience, we applied such approach in approximately 40 % of our patients (unpublished data). The rationale in performing the thoracoabdominal approach relies on the need to have the vascular control of the hepatocaval confluence, especially when parenchyma-sparing surgery is preferred. Iatrogenic injuries of this area could be even life threatening, and adequate exposure plays a fundamental role in determining their occurrence and solution. Factors as the liver stiffness play a role too, indeed when it is hard and enlarged its manipulation may be difficult using only the abdominal approach. In such circumstances the thoracoabdominal approach enables the operation not increasing the morbidity but conversely increasing the safety. Indeed this approach allows for easy lateral access to the right hemiliver with direct vision of the hepatocaval confluence, which may be handled with the surgeon's left hand.

Postoperative complications of such approach are mainly confined to the occurrence of pleural effusions. Yet, Kise et al. [6] comparing the two approaches reported increased pleural effusions in those patients who had the thoracoabdominal approach, albeit the overall outcome was better in this group. Apart from the potential selection biases of patients with underlying cirrhosis, who may develop ascites and pleural effusions because of the poor liver function rather than because of the different surgical approaches, the occurrence of hydrothorax is relatively frequent in liver surgery because of the manipulation of the diaphragm [12]. In addition, the opening of diaphragm may surely be associated with increased effusions, which nevertheless are not uncommon even using the abdominal approach. Moreover, the presence of a thoracic drain

Table 1 Review of the current literature

References	Study design	Object	Patients	Surgical technique	Intercostal space	Main findings
Tsugita et al. [3]	Retrospective	Thoracoabdominal vs. abdominal approach	31 vs. 126	From right posterior axillary line to the midline of the abdomen	7th	No differences in morbidity and mortality
Shimada et al. [4]	Retrospective	Transdiaphragmatic vs. abdominal approach	8 vs. 28	Anterolateral thoracotomy, not reported abdominal approach	n/a	Better outcome in cirrhotic patients with the transdiaphragmatic approach
Ko et al. [5]	Randomized	Transthoracic vs. abdominal	22 vs. 22	Anterolateral thoracotomy extended to the midline of the abdomen	7th or 8th	The transthoracic approach has a better outcome in cirrhotic patients
Kise et al. [6]	Retrospective	Thoracoabdominal vs. abdominal approach.	70 vs. 28	Median abdominal incision continued along the 9 th intercostals space	9th	The thoracoabdominal approach has a higher risk of pleural effusions, but lower incidence of bile leakages and pleural effusions for surgery at the hepatocaval confluence
Takenaka et al. [7]	Retrospective	Thoracoabdominal vs. transdiaphragmatic	27 vs. 20	Anterolateral thoracotomy with/without extension to the midline of the abdomen	7th	No differences in morbidity and mortality
Pocard et al. [8]	Retrospective	Transthoracic	19	Thoracotomy from the posterior to the anterior axillary line.	7th	Safe approach. No control group.
Xia et al. [9]	Retrospective	Thoracoabdominal vs. abdominal approach	92 vs. 396	Right thoracic extension from conventional subcostal incision or J incision with a right thoracic extension.	7th or 8th	No differences in morbidity and mortality
Okamura et al. [10]	Retrospective	Thoracoabdominal vs. abdominal approach	111 vs. 173	Thoracotomy or bilateral/unilateral subcostal incision	8th or 9th	Higher morbidity in the thoracoabdominal approach but no significance

n/a not available

placed during the same operation under general anesthesia, rather than in the postoperative course with local anesthesia, should be considered helpful in the diagnosis and more importantly in the management of such complication, at least for that proportion of patients that become symptomatic, and require thoracentesis in the postoperative course.

In conclusion, the thoracoabdominal approach in liver surgery is thought to increase the safety of the operation. It should not be performed in any case, but it should be a fundamental part of the liver surgeon's skills.

Conflict of interest The authors deny any conflict of interests.

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