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ORIGINAL ARTICLE

Intercostal and transthoracic trocars enable easier laparoscopic resection of dome liver lesions

Adrian K. H. Chiow, Joel Lewin, Bavahuna Manoharan, David Cavallucci, Richard Bryant & Nicholas O'Rourke

Hepatopancreatobiliary Unit, Department of Surgery, Royal Brisbane and Women's Hospital, Herston, Qld, Australia

Abstract

Background: Dome liver lesions (those in segments VII or VIII) pose a challenge to standard laparoscopic resection. The use of additional intercostal and transthoracic trocars (ITTs) potentially facilitates resection over standard subcostal laparoscopic (SSL) techniques.

Methods: A retrospective review of a prospectively collected liver resection database was performed, selecting all minor resections of segments VII and VIII using the ITT and SSL approaches. The techniques of intercostal transdiaphragmatic access are described and the surgical outcomes of the two groups compared.

Results: A total of 19 patients were analysed. The ITT group included 8 patients and the SSL group included 11. The groups were comparable in median lesion size (20 mm in the ITT group and 26 mm in the SSL group). Blood loss, operative times, morbidity and conversion rates were similar. There was no lung injury or postoperative clinical pneumothorax in any patient undergoing transdiaphragmatic access. Median hospital stay was significantly shorter in the ITT group (2 days) than in the SSL group (6 days) ($P = 0.032$).

Conclusions: The ITT approach is safe, effective and complementary to standard laparoscopic techniques for the resection of small tumours in segments VII and VIII.

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Correspondence

Adrian Kah Heng Chiow, Wesley Medical Centre, Suite 23, Level 2, 40 Chasely Street, Auchenflower, Qld 4066, Australia. Tel: + 61 7 3876 7455. Fax: + 61 7 3876 7245. E-mail: Adriankhchiow@gmail.com

Introduction

Laparoscopic liver resection has been demonstrated to be safe and effective in the removal of malignant liver tumours.[1–5] Lesions in segments VII and VIII, however, pose a challenge to standard laparoscopic techniques. One obstacle to safe resection is the often limited view of the lesion, even with high subcostal port placement. Additionally, the enforced angle of transection imposed by the ribs can lead to an unnecessarily generous anterior margin to ensure a negative margin (R0) resection. In the authors' experience, both bleeding requiring conversion and margin involvement have led to the abandonment of a purely laparoscopic approach to the resection of dome lesions.

The ribcage and diaphragm should not be considered as barriers to laparoscopic access and the placement of ports through the intercostal spaces can be performed with minimal morbidity. With a direct view of the lesion, additional ports through intercostal spaces allow the placement of instruments along all transection planes.

This report describes an experience in eight patients in whom the use of additional intercostal transdiaphragmatic and sometimes transthoracic ports allowed for the safe resection of dome lesions with minimal access. This paper describes the key technical points involved in achieving these resections and compares the outcomes in this group with those in a group of patients submitted to standard laparoscopic approaches for similarly placed lesions.

Materials and methods

All patients were retrospectively identified from a prospectively collected database of 340 laparoscopic liver resections performed from 1997 to 2013. Patients who underwent laparoscopic liver resection of lesions located solely in segments VII and/or VIII using intercostal and transthoracic trocars (ITTs) were selected. All surgeries in the ITT group were performed by a single surgeon (NO'R) between March 2011 and May 2013. Outcomes in these patients were compared with those in patients with similarly

located lesions resected using standard subcostal laparoscopic (SSL) techniques during the period from July 2004 to September 2012. Data on patient demographics, clinical status, diagnosis, operative parameters and clinical outcomes were studied. The Brisbane nomenclature was used to describe the resections performed.[6] Ethics approval was obtained prior to the commencement of this study.

Outcome measures included median operating time, median length of stay (LoS), median blood loss, median resection margin and conversions. A positive margin was defined as a surgical margin of <1 mm. Complications were classified according to Dindo–Clavien scores.[7]

Statistical analysis

Statistical analysis was performed using SPSS Version 13.0 (SPSS, Inc., Chicago, IL, USA). Continuous variables were expressed as the median (range) and compared using the Mann–Whitney *U*-test. Categorical variables were analysed using the chi-squared or Fisher's exact test as indicated. A *P*-value of <0.05 was considered to indicate statistical significance.

Laparoscopic resection using the ITT technique

Initial (abdominal) laparoscopy

General anaesthesia is induced, routinely using a single lumen endotracheal tube. Single lung ventilation, although generally unnecessary, was used in one case. The patient is positioned in a 'lazy', left lateral decubitus position (allowing rotation from almost supine to almost left lateral positions) and secured to the table using beanbags and belts, with the right arm placed in an arm gutter (Fig. 1a).

Initial access is obtained by standard abdominal laparoscopic techniques in order to visually assess the liver and its surroundings. The liver can be mobilized as required. Laparoscopic ultrasound is used to define the size and location of hepatic lesions, and their proximity to major vascular structures, and to ensure that an adequate oncologic margin can be obtained.

For large or complex resections, an inflow control sling is placed around the porta hepatis. In the event of significant bleeding during parenchymal transection, a vascular clamp (Eisner USA, LLC, Crystal Lake, IL, USA) can be rapidly applied directly to the porta, using the sling as a guide to prevent damage to the vena cava and the duodenum.

Intercostal ports

Additional 5-mm trocars are inserted through the intercostal spaces to allow instrument access and the use of a 5-mm laparoscope to further assess the dome of the liver.

There are three methods of intercostal port placement, which differ in their relation to the diaphragm: (i) ports can be placed between the ribs below the diaphragm; (ii) ports can be placed between the ribs and through the diaphragm with instrument pressure on the diaphragm imposed from below to push it against the chest wall to ensure that the lung is pushed away and not injured, and (iii) ports can be optically inserted between the ribs into the thoracic cavity and then through the diaphragm. This will require an additional laparoscopic stack, but offers a better view and line of resection for posteromedial tumours.

In the latter two methods, 5-mm balloon ports (Applied Medical Resources Corp., Rancho Santa Margarita, CA, USA) are ideal as the balloon can be inflated and ports retracted, pulling the diaphragm back against the chest wall and enlarging the field of view. All three of these methods may be employed in a single patient depending on the technical requirements of the resection, such as in Fig. 1b. Transiting the chest cavity, as in method (iii), is used for lesions located more posteromedially.

Parenchymal transection

The line of transection is marked with diathermy and parenchymal transection performed with a 5-mm dolphin tip laparoscopic LigaSure™ 'V' (Covidien, Inc., Mansfield, MA, USA). This energy device works best when saline is applied simultaneously, which can be done through a suction–irrigation device, or by placing a saline infusion to the port holding the LigaSure™ to allow saline to drip down the device. Saline irrigation allows for clear visualization through the transection plane and also prevents coagulated tissue from adhering to the jaws. The margin is confirmed with laparoscopic ultrasound. Hem-o-Lok® clips (Weck Surgical Instruments, Teleflex Medical, Inc., Durham, NC, USA) can be applied to larger vessels. These also help to define oncologic margins as they are hyperechoic under ultrasound, and allow for the definition of the transection plane, even when the specimen is compressed against the liver.

Port removal

Transdiaphragmatic ports are removed under direct vision. Closure of the diaphragmatic port sites is performed from below, laparoscopically, with non-absorbable sutures after suctioning of the pleural space. The specimen is usually extracted in a retrieval bag through an extension of the 12-mm port at the midline. Drains are not routinely used.

Standard subcostal laparoscopic technique

Initial positioning and subumbilical access are similar to those used in the ITT technique. Additional 5-mm ports are inserted in the epigastric and right subcostal region. A Pringle's sling using a vessel loop secured with a Hem-o-Lok® clip is routinely prepared to guide portal clamping if necessary. Full mobilization of the right lobe of the liver is performed. The margin of the resection is marked under direct ultrasound guidance. Parenchymal transection is performed with a laparoscopic LigaSure™. Larger vessels or bile ducts are clipped with ligaclips, Hem-o-Lok® clips or surgical staplers. The specimen is placed in a retrieval bag and is extracted through a pre-existing scar or an extension of a port site wound. Drains are not routinely placed.