Editorial

Laparoscopic liver resection—education and training

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Background

Since the first wedge resection reported in 1991 (1), laparoscopic liver surgery has had a slow but stepwise development, gradually rising interest among the hepatobiliary community. Case series, comparative studies and pooled results from pioneering centres started soon to report the safety and reproducibility of laparoscopic liver resections (LLRs), eventually speculating advantages over the standard open approach (2-5).

In 2008, the first Consensus Conference on LLR was held in Louisville and since then, the number of laparoscopic resections increased exponentially, including minor and major resections, anatomical resections and living donor hepatectomies (6-14). As a result, the Second International Consensus Conference in Morioka [2014], gathered experts in the hepatobiliary field all over the world to produce recommendations that represent a landmark in the laparoscopic surgery of the liver (15). There are currently more than 9,000 LLRs reported for both benign and malignant indications with benefits in terms of the postoperative morbidity, blood loss, length of hospitalization and pain management, maintaining safe oncological outcomes (16-18). Despite this, this technique is still somehow limited to referral centres and the widespread adoption of LLR is still hampered; this is likely due to the technical difficulties, requiring experience in both hepatobiliary and complex laparoscopic surgery together with specific, intense training (19). It has extensively been reported in fact, that in order to obtain good and safe outcomes after LLR, a learning curve (LC) process is necessary; as stressed during the Morioka Consensus conference and later during the European Guidelines meeting in Southampton in 2017, the need for and incremental, stepwise progression trough the learning curve is recommended in order to minimize harm to patients (15,20). Despite this, the evidence concerning learning curve is still confusing and frequently biased by mixed results and by the lack of adequate outcomes assessment; furthermore, the exact training and the tasks that a young fellow should fulfil are currently unknown.

Learning curve and training: state of the art

The first attempt to provide a cut-off number for completion of the learning curve in LLR was made in 2006 by Vigano (21) and colleagues; by using a CUSUM analysis, they reported a case-load of 60 resections to cut down conversion rate. Later, a similar analysis focused on operative time was run by Tomassini and colleagues disclosing a number of 160 cases (22). Both manuscripts were limited by the inclusion of unselected laparoscopic procedures without a subgroup analysis according to the type of resections, degree of difficulty and patient's characteristics as well as background liver disease; LLRs and their learning curves in fact are presumably very different depending on the patient's characteristics (comorbidities, cirrhosis, neoadjuvant chemotherapy), the disease presentation (location, size, number of lesions) and the type of procedure (major *vs.* minor, anatomical *vs.* non-anatomical, anterolateral *vs.* posterosuperior segments).

Recently, more specific and detailed analysis according to type of procedures have been performed disclosing a learning curve of 15–20, 25–60 and 45–70 cases respectively for left lateral sectionectomies, minor resections, and major hepatectomies (20,23); furthermore, laparoscopic left lateral sectionectomy for paediatric living donor liver transplantation was reported to be successfully taught and

reproduced thanks to a proctored training, achieving the LC after 25 procedures (24).

Another issue that should be raised in this setting is the outcome on which the learning curve should be evaluated on: according to the available literature, different statistical techniques and different outcomes, mainly intraoperative parameters, were used to assesses surgeon's progression. Despite being intraoperative outcomes such as operative time, blood loss and conversion rate, a good surrogate of technical improvements, the chance of missing the postoperative course of patients should not be underestimated; computing the LC on patient's course after surgery certainly introduces some bias related to individual's characteristics but is definitely a good measure of surgical practice. A composite variable made up of intraoperative measures (operative time, blood loss, intraoperative complications, conversions) and postoperative outcomes (morbidity, mortality, hospitalization), should be the correct task to look into in order to assess surgical improvements. By these means, the young surgeon could focus on the whole surgical practice, improving himself technically during the procedure and taking care of the postoperative course of the patient, aiming to standardization and providing high quality of care.

Together with the recent widespread acceptance of laparoscopic liver surgery, several leading centres and surgeons dedicated to this field have been providing specific training by means of fellowships, courses and mentored programs to young surgeons (25). Proctors are generally "self-taught" surgeons who pioneered and implemented LLR since its introduction, who already underwent the process of "trial and error", and who developed and standardized their technique. Thanks to this, young trainees can focus on the acquisition and development of their surgical skills, concentrating on the learning curve under the guidance of experts in the field. As recently reported by Halls and colleagues indeed, the learning curve of young surgeons is much more rapid and easy to achieve than the one experienced by the "self-taught" surgeons. Forty-seven LLR are necessary for fellows to achieve the same outcomes that are measured after 150 procedures performed by the pioneering proctors. This means that the learning curve could be reduced by specific training, technological innovations and standardization, but especially by the guidance of experts who implemented LLR in their centers (26).

The "IDEAL" training

First and most important, young surgeons should keep in mind that the training for LLR as for most other disciplines should be seen as an evolving process that starts before the surgical procedure itself; dry boxes, video reviewing and case by case discussions are the first steps to get familiar with what is going to be faced during the training. Feedback of the mentor in this phase is a big resource for the fellow to ameliorate himself and proceed to further deep learning (24,27).

Preoperative anatomical reconstructions and reviewing of the surgical instruments and their use, helps improving fellow's confidence during the surgical procedure itself.

Operations should be then broken down in steps (i.e., trocar position, preparation of Pringle maneuver, intraoperative ultrasound, mobilization of the liver, pedicle dissection, hepatic veins exposure…) and reviewed with the proctor multiple times in order to speed up the learning process and facilitate the approach to the technique. Every laparoscopic liver resection is in fact made up of different steps each having potential pitfalls; the difficulty of accurately stage the disease through the intraoperative ultrasound, the challenges of managing potential bleeding and the different view during liver mobilization are only examples of what a surgeon has to get through during a laparoscopic resection of the liver.

Once the trainee has gained sufficient knowledge, the best way to proceed is to assist different procedures of the proctor in order to familiarize with the movements and the maneuvers; furthermore, some steps could be performed by the fellow himself displaying a stepwise approach to the operation.

Finally, the fellow should start to perform procedures on his own, with the assistance of the proctor that is available to take over in case of difficulties. In this phase of the training it is very important to gradually approach procedures of higher difficulty. It has been well shown in fact that LLR could be graded according to degree of difficulty mainly considering location of the tumor, presence of cirrhosis and type of hepatectomy (28). In this setting the young trainee should start by performing easy cases (wedge resections in the anterolateral segments in normal livers) and achieving more complex and demanding procedures (major hepatectomies and anatomical resections in the posterosuperior segments in cirrhotic livers) once

confidence and caseload have been reached. By these means, the LC of a fellow could be fulfilled maintaining safety for the patient and ensuring improvements in a stepwise fashion. A comprehensive assessment of aims and tasks rather than a cut-off number should be the correct way to look at training and LC, especially in such a complex field.

In conclusion, the LC in laparoscopic liver resection is long and made up of several hurdles and challenging tasks. Training should be performed in referral centres trough a dedicated and stepwise systematic learning. The feedback and guidance of an expert is necessary to improve both the technical skills of the young fellow and the intra and postoperative outcomes of the patient who can eventually benefit of a high quality of care.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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