Editorial

Minimally invasive liver resection: has the time come to consider robotics a valid assistance?

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Minimally invasive liver resection (MILR) has been steadily increasing worldwide. Since its introduction in the early 1990s, initially adopted in cases of wedge and minor anatomical resection for benign hepatic lesions, MILR has been extended to major liver resection and for malignant hepatic lesions (1). Laparoscopic lateral sectionectomy has progressively become a standard operation (2).

Despite the lack of availability of randomized clinical trials to date, the exponential growth of the application of this technique, albeit in predominantly high-volume hepatic and laparoscopic centers, allowed extensive comparative analyses between open and laparoscopic liver resection. Though most evidently in minor liver resections, the laparoscopic approach led to lower postoperative morbidity (such as wound infection, blood transfusions, pulmonary embolism, liver failure, and biliary leakage), shorter hospital stay and less blood loss with respect to the open procedure, with similar oncologic outcomes (3,4).

Despite its exponential and progressive increase, the percentage of liver resections performed laparoscopically on a national health care level in many countries is still nowhere near other gastro-intestinal applications. For example, on the basis of a case-volume analysis, in Netherlands (5) and in Italy (6) only 11% till 2014 and 10.3% till 2015 respectively of the total number of liver resections were performed laparoscopically. Considering the steady increase in implementation of the minimally invasive approach over time, these percentages are destined to grow. In selected highly specialized centers the percentage of MILR performed yearly has increased up to 40–50% over the last few years, and even up to 80% if hand-assisted or hybrid techniques (7) are considered.

Slow adoption of minimally invasive liver surgery is mainly due to the traditional disadvantageous features of conventional laparoscopy. The restricted motion of the rigid straight laparoscopic tools with few degrees of freedom, the fulcrum effect, together with an intrinsic non-ergonomic nature and the 2-dimensional view, are poorly suited to the peculiar, complex liver anatomy. Especially during segmentectomies and subsegmentectomies of the postero-superior segments, the need to mobilize the liver attachments in a limited manoeuvring space, together with the increased risk of uncontrollable haemorrhage, tend to discourage the surgeon, who consequently conducts a greater number of straight section-lines, resulting in major hepatectomies, even for small or isolated liver nodules (8).

The Louisville Statement (9) in 2008 draws the indication of MILR for solitary lesions of 5 cm or less, located in liver segments Sg2, Sg3, Sg4b, Sg5, Sg6 and requiring segmentary resections or left lateral sectionectomy, while the panel of experts suggested that major liver resections should be reserved for experienced surgeons in specialized centers. Although since 2009, the number of major and anatomic laparoscopic resections has steadily increased, minor resections still comprise the vast majority of procedures in clinical practice (10). Moreover, although in 2014, during the second consensus meeting, held in Morioka (Japan) (10) further expansion of the indications for MILR was discussed, the widespread applicability and reproducibility of major hepatectomies and resection of tumors in the postero-superior segments were once more labelled non-standard procedures.

Thus, laparoscopic liver resection remains a technically challenging procedure, that requires particular skill by the surgeon and a certain process of acceptance in specialized units. This is the reason why most liver surgeons are still "open" surgeons.

The concerns that have interfered with the widespread acceptance of MILR surfaced in parallel with the current progressively increasing trend toward performing limited resections (i.e., parenchymal-sparing liver surgery) for malignant lesions (8). Whenever technically feasible, parenchyma-sparing liver surgery appears to reduce morbidity without changes in long-term results and offers the possibility of repeated hepatectomies in case of liver recurrence (8).

The greater acceptance of less extensive liver resection (in terms of saving parenchyma) for malignant disease has been followed by a not so rapid paralleling shift towards the diffusion in the technical feasibility of laparoscopic liver resection. Therefore, the introduction of technical innovation, such as robotic surgical system, which reduces some of the typical downsides of conventional laparoscopy, might perhaps fill this gap in certain situations.

The advantage of the stability, tremor filtration, 3-dimensional view and superior movements of the robotic arms would be particularly suitable for enabling more complete dissection in demanding areas. In particular the EndoWrist® function makes it easier for the surgeon to reach deep intraparenchymal and postero-superior liver areas, makes it easier to turn the liver hilum around, and enables curved parenchymal transection, which can only be reached with difficulty with the conventional straight current laparoscopic instrument and camera system. Therefore, lesions in the postero-superior segments of the liver, as well as those with major vascular involvement, which are very complicated when approached in laparoscopy, could be more easily approached in robotic surgery. In particular, robotic assistance may be of particular effect in facilitating a parenchymal-sparing liver resection, while the conventional laparoscopic approach usually leads to major liver resection, sacrificing a substantial volume of normal liver (8,11). In fact, some papers showed that parenchymal-sparing resection of the postero-superior segments was performed more often by a robotic approach in comparison with laparoscopic procedures, which commonly extend to a major resection (11). An additional advantage is less surgeon fatigue, especially in longer procedures (5).

Nevertheless, although several studies have been published regarding robotic liver resection (12-14), showing its safety and feasibility, the comparison with open and conventional laparoscopic techniques is at the beginning, and no high quality scientific evidence is available so far. Essentially, it seems that robotic liver resection could maintain the typical benefits of minimally invasive surgery (shorter operative times, lower blood loss, and shorter hospital stays) compared to open, but its superiority over laparoscopy is not always so evident and sometimes even discordant (12-14).

Another potentially limiting factor in the widespread adoption of laparoscopic liver resection is its long learning curve, with up to 60–75 resections needed for competency (15). Thus, although data regarding this issue are still premature, another potential appeal of the robotic technique, as well as what has already been demonstrated in other gastro-intestinal complex procedures, is the possibility of a steeper learning curve than laparoscopic hepatectomy (15).

Another aspect, one of the most criticized weaknesses, is the presumed higher costs of robotics, without consistently evident superiority in terms of clinical benefit and better outcomes, compared to pure laparoscopic surgery. The increased cost of minimally invasive equipment, and the even more considerable expense incurred with robotic surgery are evident, and they cannot be ignored. However, the potential shorter hospital stay and the theoretical larger proportion of patients subject to liver resections by minimally invasive technique, might compensate the increase in cost. Unfortunately, again comparison data thus far in high quality cost-effectiveness studies are insufficient and sometimes even inconsistent among different reports (15).

In conclusion, the greatest potential clinical benefit of the robotic system over conventional laparoscopy is presumably to make amenable minor resection of difficult located liver lesions (postero-superior segments).

Moreover, the possibility to work with endowristed instruments makes the robotic system particularly suited for multiplanar curved liver transaction, such as are required in parenchymal-sparing resection, and during hilar dissection they allow parenchymal preservation, even for tumors close to a hepatic vein and portal pedicles.

The potential of robotics to better resemble the techniques of parenchymal-sparing open liver resection compared to conventional laparoscopy may represent an interesting option to expand surgical indications, in line with the trend of increasingly emerging parenchyma-preserving indications. At the same time, lesions located in the postero-superior segments were annually performed laparoscopically at a higher frequency, reflecting the technical evolution of MILR, and, thus, technical innovative tools such as robotics can further increase this percentage.

What should be kept in mind is that robotics is a technical option of minimally invasive surgery, potentially overcoming some of the drawbacks of traditional laparoscopy, but it must not influence or create a new indication with respect to the oncological criteria. Thus, the role of surgical resection, especially in particular cases such as bulky tumors invading surrounding structures and the need of vascular and biliary reconstructions, should be discussed at a multidisciplinary level, while the operative approach should be chosen by the surgeon accordingly to the indications case-by-case. In other words, the two approaches should not be confused: the "minimally invasive" access, and the "minimally invasive" parenchymal liver resection. The former is the technical approach, the latter is the surgical technique depending on the oncological criteria. This two are not alternative but complementary approaches.

Unfortunately, due to the paucity of high quality comparative results to date, conclusive statements on the potential superiority of robotic surgery over laparoscopy, and the possibility of extending the range of application of minimally invasive liver surgery are not possible.

Therefore, the worldwide rise of audited national registers, national survey inquiries (6) and coordinated multi-center programs (3,5) on the appropriateness of MILR and the diffusion of robotic liver resection, especially given the difficulty in establishing randomized controlled trials, is highly desirable.

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Footnote

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References

1. Nguyen KT, Gamblin TC, Geller DA. World review of laparoscopic liver resection-2,804 patients. Ann Surg 2009;250:831-41.
2. Chang S, Laurent A, Tayar C, et al. Laparoscopy as a routine approach for left lateral sectionectomy. Br J Surg 2007;94:58-63.
3. Bagante F, Spolverato G, Strasberg SM, et al. Minimally Invasive vs. Open Hepatectomy: a Comparative Analysis of the National Surgical Quality Improvement Program Database. J Gastrointest Surg 2016;20:1608-17.
4. Gobardhan PD, Subar D, Gayet B. Laparoscopic liver surgery: An overview of the literature and experiences of a single centre. Best Pract Res Clin Gastroenterol 2014;28:111-21.
5. Nota CL, Rinkes IHB, Hagendoorn J. Setting up a robotic hepatectomy program: a Western-European experience and perspective. Hepatobiliary Surg Nutr 2017;6:239-45.
6. Aldrighetti L, Belli G, Boni L, et al. Italian experience in minimally invasive liver surgery: a national survey. Updates Surg 2015;67:129-40.
7. Nguyen KT, Geller DA. Laparoscopic liver resection--current update. Surg Clin North Am 2010;90:749-60.
8. Casciola L, Patriti A, Ceccarelli G, et al. Robot-assisted parenchymal-sparing liver surgery including lesions located in the posterosuperior segments. Surg Endosc 2011;25:3815-24.
9. Buell JF, Cherqui D, Geller DA, et al. The international position on laparoscopic liver surgery: The Louisville Statement, 2008. Ann Surg 2009;250:825-30.
10. Wakabayashi G, Cherqui D, Geller DA, et al. Recommendations for laparoscopic liver resection: a report from the second international consensus conference held in Morioka. Ann Surg 2015;261:619-29.
11. Efanov M, Alikhanov R, Tsvirkun V, et al. Comparative analysis of learning curve in complex robot-assisted and laparoscopic liver resection. HPB (Oxford) 2017;19:818-24.

12. Ocuin LM, Tsung A. Robotic liver resection for malignancy: Current status, oncologic outcomes, comparison to laparoscopy, and future applications. J Surg Oncol 2015;112:295-301.
13. Qiu J, Chen S, Chengyou D. A systematic review of robotic-assisted liver resection and meta-analysis of robotic versus laparoscopic hepatectomy for hepatic neoplasms. Surg Endosc 2016;30:862-75.
14. Hu L, Yao L, Li X, et al. Effectiveness and safety of robotic-assisted versus laparoscopic hepatectomy for liver neoplasms: A meta-analysis of retrospective studies. Asian J Surg 2017. [Epub ahead of print].
15. Beard RE, Tsung A. Minimally Invasive Approaches for Surgical Management of Primary Liver Cancers. Cancer Control 2017;24:1073274817729234.

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