Outcomes of hepatopancreatic robotic surgery: update from the literature-pancreatic surgery

E Ortiz Oshiro*, J Dziakova, B Lasses Martínez

Abstract
Introduction
The first reports on Da Vinci system application for hepatic and pancreatic procedures appeared in 2003. Ten years after, several teams from all around the world have incorporated these procedures for a variety of indications. This review tried to analyse the outcomes reported in the literature on hepatopancreatic robotic surgery, to find out the current trend of the most experienced groups. In this first part, robotic pancreatic surgery was evaluated.

So far, five systematic reviews, nine nonrandomised comparative studies and a number of case series and case reports have been reported on this topic. No prospective randomised studies have been reported till now. In spite of these limitations, the outcomes of robotic pancreaticoduodenectomy seems to be encouraging in terms of safety and feasibility, not increasing morbidity or mortality incidence respecting to open surgery, and allowing patients to benefit from minimally invasive surgery postoperative advantages. Otherwise, oncological results remain poorly cleared, mainly due to short follow-up. With regard to distal pancreatectomy, comparison with laparoscopic approach adds some important information. Spleen preservation seems to be the real interest of robotic pancreatic surgery, according to most of the authors.

Conclusion
Robotic approach seems to enlarge the number of patient candidates to benefit from minimally invasive surgery. Specific advantages mentioned in the literature are related to blood loss, hospital stay, overall complication rate and the rate of spleen preservation in distal pancreatectomies. Nevertheless, further randomised and controlled studies are needed to support the growth of robotic pancreatic surgery, mainly when addressing to oncological indications.

Introduction
The first report on hepatopancreatic robotic surgery in the literature, as far as we know, comes from Giulianotti’s team in 2003. There were no specific outcomes from about 13 pancreatic resections and two hepatic resections, but 9.3% of morbidity rate and 1.5% of mortality rate for the whole group of 207 different procedures in 193 patients were reported.

After the pioneers, different groups slowly incorporated the robotic approach to perform these complex procedures. From 2008 to 2009, several Asian, European and Latinoamerican groups reported their initial experience and results in robotic pancreatic and hepatic procedures.

Since then, greater experience has been reported, mainly as case series. Published outcomes are heterogeneous, pointing at technical advantages when compared with conventional laparoscopic approach, and some clinical benefits as less blood loss or less hospital stay for some teams in some procedures. There is no consensus at the moment about superiority of robotic hepatopancreatic surgery versus conventional laparoscopic or open procedures.

Our aim is to analyse the outcomes reported in the literature on hepatopancreatic robotic surgery, to find out the current trend of the most experienced teams.

Pancreatic surgery
Due to retroperitoneal position, proximity to major vessels and nature of the pancreatic gland, and moreover the need of three anastomosis for restoration of enteric continuity in many cases, pancreatic surgery has been considered one of the best fields where robotic approach might help with limitations of laparoscopy, enhancing the possibility to offer the patient the advantages of the minimally invasive approach and precise technique.

To date, five systematic reviews, eight nonrandomised comparative studies and a number of case series and case reports have been reported on this topic. The largest published study at the moment, to our knowledge, is Zureikat et al. analysing the outcomes of 132 robotic pancreaticoduodenectomies (RPDs), 83 distal pancreatectomies (DPs) and 13 central pancreatectomies (CPs), among other pancreatic procedures.

Robotic pancreaticoduodenectomy
As mentioned above, the first RPD was published 10 years ago. A number of case series have been published since then with encouraging results, most of them from a few centres around the world.

Around 500 RPDs have been reported till now: the majority of them as case series. Other RDP outcomes have been comparatively reported
in retrospective studies. We will review the published results of the most experienced teams, (Table 1, Case series RPD, arranged according to number of cases 8–16 and Table 2, Comparative studies17–20).

Intraoperative outcomes: operative time – blood loss – conversion

A wide range of time needed to perform RPD has been reported: from 420 (360–510) min14 to 719 ± 187 min15. Comparison with open procedure uses to show that the robotic approach is longer. Nevertheless, some authors state there are steps of the procedure that may be improved and shortened by robotic approach: lymph node dissection, the creation of the retropancreatic tunnel, the resection of the uncinate process and the reconstruction phase9 (Table 1, Table 2).

Concerning blood loss, amounts from 153 ± 43 mL16 to 485 (50–3500) mL18 have been reported. Compared with open surgery, blood loss seems to be inferior17,19,20.

Reported conversion to open rate ranges from 0%11,16,19 to 37.5%14. Main reasons for conversion are bleeding, difficult dissection and technical problems. Robotic assistance might help to reduce the risk of conversion to open if compared with traditional laparoscopic approach, but this has not been shown till now, because published studies tend to compare robotic approach to open17–20.

Postoperative outcomes: po stay – morbidity – leak – pathology

A minimally invasive approach is supposed to reduce the length of stay (LOS). Reported LOS is between 9.614 and 31.9 ± 8.4 days12. Differences in health systems from the different countries may account for this wide range10. All the four comparative studies find shorter LOS for the robotic group17–20 (Table 1, Table 2).

Robotic approach does not seem to enhance the open surgery outcomes with regard to morbidity. Case series show mean incidences between 30% and 70%. Comparative studies find no differences between open and robotic groups, with one exception19. Fistula rate varies widely in case series, from 6.3%11,12 to 38.2%11.

Oncological safety is one of the key points when evaluating robotic

Table 1 Case series robotic pancreaticoduodenectomy

<table>
<thead>
<tr>
<th>Author/year (reference)</th>
<th>n</th>
<th>% malignant</th>
<th>Operative time (min)</th>
<th>Blood loss (mL)</th>
<th>Conversion to open</th>
<th>Length of hospital stay (days)</th>
<th>Morbidity</th>
<th>Fistula rate</th>
<th>90-day mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zureikat et al.8, b</td>
<td>132</td>
<td>80.3%</td>
<td>527 ± 10310</td>
<td>–</td>
<td>8%</td>
<td>10 (4–87)11</td>
<td>62%</td>
<td>17%</td>
<td>5</td>
</tr>
<tr>
<td>Giulianotti et al.9</td>
<td>60</td>
<td>–</td>
<td>421 (240–660)12</td>
<td>394 (80–1500)12</td>
<td>18.3%</td>
<td>22 (5–85)13</td>
<td>–</td>
<td>31.3%</td>
<td>2</td>
</tr>
<tr>
<td>Zeh et al.10</td>
<td>50</td>
<td>74%</td>
<td>568 (536–629)14</td>
<td>350 (150–625)14</td>
<td>W16%</td>
<td>10 (8–13)15</td>
<td>56%</td>
<td>22%</td>
<td>1</td>
</tr>
<tr>
<td>Boggi et al.11 Prospect</td>
<td>34</td>
<td>–</td>
<td>597 (420–960)16</td>
<td>220 (150–400)16</td>
<td>0</td>
<td>23 (10–86)17</td>
<td>55.9%</td>
<td>38.2%</td>
<td>1</td>
</tr>
<tr>
<td>Zhan et al.12</td>
<td>16</td>
<td>–</td>
<td>479.7 ± 111.518</td>
<td>633.8 ± 264.518</td>
<td>–</td>
<td>31.9 ± 8.419</td>
<td>31.25%</td>
<td>6.3%</td>
<td>–</td>
</tr>
<tr>
<td>Chan et al.13</td>
<td>8</td>
<td>62.5%</td>
<td>478 (270–692)10</td>
<td>200 (30–300)10</td>
<td>8.3%</td>
<td>12 (6–21)11</td>
<td>–</td>
<td>33.3%</td>
<td>0</td>
</tr>
<tr>
<td>Narula et al.14 d</td>
<td>5</td>
<td>–</td>
<td>420 (360–510)14</td>
<td>–</td>
<td>37.5%</td>
<td>9.6</td>
<td>–</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vasconcellos-Macedo et al.15</td>
<td>5</td>
<td>–</td>
<td>640 (435–790)14</td>
<td>–</td>
<td>20%</td>
<td>25.8 (12–52)16</td>
<td>60%</td>
<td>20%</td>
<td>0</td>
</tr>
<tr>
<td>Horiguchi et al.16</td>
<td>3</td>
<td>100%</td>
<td>703 ± 14114</td>
<td>118 ± 7214</td>
<td>0</td>
<td>26 ± 1214</td>
<td>66.6%</td>
<td>33.3%</td>
<td>0</td>
</tr>
</tbody>
</table>

*30-day mortality.
†Largest series up to now. Hybrid technique.
‡Data from 12 patients undergoing robotic pancreatic resection, including eight Whipple’s operation, two spleen-preserving distal pancreatectomy, one double bypass and one cystojejunostomy.
§Hybrid techniques (laparoscopic and robotic). Data from 5 patients (excluding three conversions to open).
¶Median (range), **mean (range) and ***mean ± SD.

<table>
<thead>
<tr>
<th>Author/year procedure (reference)</th>
<th>n</th>
<th>Malignant</th>
<th>Mean tumour size (cm)</th>
<th>Operative time (min)</th>
<th>Blood loss (mL)</th>
<th>Conversion</th>
<th>Mean length of hospital stay (days)</th>
<th>Morbidity</th>
<th>Mortality</th>
<th>RO</th>
<th>Mean lymph node obtained</th>
<th>Spleen preservation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buchs et al.17 RPD</td>
<td>R = 44 O = 39</td>
<td>75%</td>
<td>69.2%</td>
<td>444 ± 93.5*</td>
<td>559 ± 135*</td>
<td>P = 0.0011</td>
<td>387 ± 334* 827 ± 439* P = 0.0001</td>
<td>4.5%</td>
<td>13 ± 7.5* 14.6 ± 9.5* P = 0.4</td>
<td>36.4%</td>
<td>48.7%</td>
<td>4.5% 100%</td>
</tr>
<tr>
<td>Chalikonda et al.18 RPD</td>
<td>R = 30 O = 30</td>
<td>62%</td>
<td>62%</td>
<td>379 (363–727)**</td>
<td>366 48 (213–602) P = 0.0005</td>
<td>485 (50–3500)** 775 (100–5000) P = 0.13</td>
<td>10%</td>
<td>9.79 ± 41.5 ± 93* P = 0.043</td>
<td>30% 43%</td>
<td>4.5% 0</td>
<td>4% 0</td>
<td>100% 87% P = 0.02</td>
</tr>
<tr>
<td>Zhou et al.19 RPD</td>
<td>R = 8 O = 8</td>
<td>100%</td>
<td>75%</td>
<td>718 ± 186*</td>
<td>420 ± 127.7* P = 0.011</td>
<td>153 7543.4* 210±53.18 P = 0.045</td>
<td>0%</td>
<td>16.4 ± 41.4* 24.3 ± 7.1 P = 0.04</td>
<td>25% 75%</td>
<td>4% 0</td>
<td>12 5%</td>
<td>100% 83% P = 0.05</td>
</tr>
<tr>
<td>Lai et al.20 RPD</td>
<td>R = 20 O = 67</td>
<td>75%</td>
<td>79.1%</td>
<td>491.5 ± 94*</td>
<td>264.9 ± 63.7* P = 0.01</td>
<td>247 (50–889)** 774.8 (50–8000) P = 0.03</td>
<td>5%</td>
<td>13.7 ± 6.1* 25.8 ± 23.1 P = 0.02</td>
<td>50% 43%</td>
<td>3% 0</td>
<td>10% 84%</td>
<td>102* 148 P = 0.99</td>
</tr>
<tr>
<td>Hanna et al.22 DP</td>
<td>R = 39 L = 18 O = 13</td>
<td>56.4%</td>
<td>–</td>
<td>223.1</td>
<td>205.3</td>
<td>233.3</td>
<td>0.48</td>
<td>525.3 797.2 1171.2 P = 0.01 (R vs. O)</td>
<td>38.5% 22.2%</td>
<td>6.8 (3–21)* 9.8 (4–9)* 17.2 (6–8)* P &lt; 0.001 (R vs. O)</td>
<td>33.3% 27.8%</td>
<td>2.6% –</td>
</tr>
<tr>
<td>Daouadi et al.24 DP</td>
<td>R = 30 L = 94</td>
<td>73%</td>
<td>56% P &lt; 0.05</td>
<td>3.1 ± 1.2* 3.4 ± 1.6*</td>
<td>0.604</td>
<td>293 ± 93* 372 ± 141* P = 0.01</td>
<td>150 (100, 300) 150 (100, 300) P = 0.68</td>
<td>0% 16%</td>
<td>6.1 ± 1.7* 7.1 ± 4.0 P = 0.183</td>
<td>66% 64%</td>
<td>0 1.1% P = 1</td>
<td>95% 18%</td>
</tr>
<tr>
<td>Kang et al.25 DP</td>
<td>R = 20 L = 25</td>
<td>0%</td>
<td>0</td>
<td>3.5 ± 1.3* 3.0 ± 1.4</td>
<td>1.4</td>
<td>348.7 ± 121.8* 258 ± 118.6 P = 0.024</td>
<td>372 ± 341.5* 420.2 ± 445.5* NS</td>
<td>–</td>
<td>7.1 ± 2.2* 7.3 ± 3 NS</td>
<td>10% 16% NS</td>
<td>0 0</td>
<td>– – 95% 64% 0 P = 0.027</td>
</tr>
<tr>
<td>Waters et al.23 DP</td>
<td>R = 17 L = 18 O = 22</td>
<td>0%</td>
<td>0.03</td>
<td>2 ± 1* 4 ± 3 6 ± 4</td>
<td>0.06</td>
<td>298 (191–418)** 224 (100–346) 234 (136–437) P = 0.01</td>
<td>279 ± 20 (1200)** 667 ± (50–7000) 681 ± (50–3300) P = 0.17</td>
<td>R = 11.8% L = 11.1% – P = 0.09</td>
<td>4 (2–6)* 6.4 (3–14)* 8 (3–25) P = 0.04</td>
<td>17.6% 33.3% 18.2% P = 0.4</td>
<td>0 0</td>
<td>100% 100% P = 0.08 (R vs. L)</td>
</tr>
<tr>
<td>Kang et al.27 CP</td>
<td>R = 5 O = 10</td>
<td>–</td>
<td>–</td>
<td>432 ± 65.7* 286 ± 90</td>
<td>0.013</td>
<td>275 ± 221.7* 85.6 ± 490 P = 0.038</td>
<td>0 14.6 ± 7.7* 22.1 ± 13.3 NS</td>
<td>–</td>
<td>20% 50% NS</td>
<td>0 0</td>
<td>– –</td>
<td>– –</td>
</tr>
</tbody>
</table>

CP: central pancreatectomy; DP: distal pancreatectomy; RPD: robotic pancreaticoduodenectomy; R: robotic approach; O: open approach; L: laparoscopic approach.

*15 conversions: five to open, 10 to hand-assisted laparoscopic procedure.

*Among patients with pancreatic adenocarcinoma: 36% of laparoscopic group (5/14) had microscopically positive pancreatic transection margins compared with zero (0/13, P < 0.005) in the robotic group.

*Benign and borderline malignant tumours of the pancreas.

*Mean ± SD, **mean (range) and ***median (25th, 75th percentile).
approach. There are still scarce reports providing good quality information on radicality, mean lymph node obtained and medium-long follow-up. Moreover, there are no randomised studies, although one recent prospective case-matched study has found higher incidence of R0 resection with robotic approach comparing with open pancreateoduodenectomy (100% vs. 87%, $P = 0.02$)\textsuperscript{18}. Zhou et al.\textsuperscript{19} also demonstrated increased R0 resections (100%) in the robotic group comparing with open approach (83.3%, $P = 0.05$).

With regard to the number of obtained lymph nodes, some studies show no significant difference between open and robotic approach\textsuperscript{18,20} while others demonstrate advantages for robotic procedure: 16.8 versus 11 nodes ($P = 0.02$)\textsuperscript{17}.

Distal pancreatectomy

Laparoscopic DP is becoming more and more common than its open counterpart. Some authors believe that the real benefit of robotic assistance in this procedure is to enhance possibilities of spleen preservation in suitable cases\textsuperscript{9}.

To our knowledge, four case series of DP have been published (Table 3), with variable results\textsuperscript{8,9,11,21}. Comparative outcomes reported by four authors since 2010 are more remarkable: two of them comparing with traditional laparoscopic approach\textsuperscript{22,23} and two of them comparing with laparoscopic and open approach too\textsuperscript{24,25} (Table 2).

**Intraoperative outcomes:** operative time – blood loss – conversion

The largest published series of robotic DP ($n = 83$) is at the moment Zureikat et al.\textsuperscript{8}, with 72.3% of cases performed for malignancy (neuroendocrine, pancreatic ductal adenocarcinoma and metastatic lesions) (Table 2, Table 3).

There is no consensus currently about robotic DP advantages with regard to operative time, blood loss or conversion incidence. Time needed to perform this procedure is considered equal than their open or laparoscopic counterparts for some teams\textsuperscript{22}, and longer for others\textsuperscript{23}. Reports comparing robotic and laparoscopic approaches do not agree either: Daouadi et al.\textsuperscript{24} found the time for robotic procedure to be shorter and Kang et al.\textsuperscript{25} found just the opposite. Blood loss has been found not to be different between robotic and traditional laparoscopic approaches\textsuperscript{23,25}, but inferior to blood loss in open approach in some reports\textsuperscript{22}.

Conversion rate has been described as significantly inferior when compared with traditional laparoscopic approach by some teams\textsuperscript{25}, and similar for both approaches by others\textsuperscript{22,23}. An interesting remark from Hanna et al.\textsuperscript{22} is the possibility to convert robotic DP to hand-assisted laparoscopic procedure instead of converting to open surgery.

**Postoperative outcomes:** po stay – morbidity – pathology

Length of hospital stay has been found very variable in case series, as reported for RPD. In comparative studies, postoperative hospital stay has been found to be similar between robotic DP and traditional laparoscopic DP\textsuperscript{24,25}, but shorter when we compare any of them with open approach\textsuperscript{22,23} (Table 2, Table 3). Only one of the four comparative studies found a difference in morbidity rate between groups: higher for the open group\textsuperscript{22}. The other three studies could not demonstrate any difference. Pancreatic fistula was a frequent complication in all case series, ranging from 9.1%\textsuperscript{22} to 56.3%\textsuperscript{12}.

Pathology outcomes have been reported only by two studies. With regard to achievement of R0 resection, Waters et al.\textsuperscript{22} found no differences

<table>
<thead>
<tr>
<th>Table 3 Case series distal pancreatectomy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author/year (reference)</strong></td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Zureikat et al.\textsuperscript{8}</td>
</tr>
<tr>
<td>Giulianotti et al.\textsuperscript{9}</td>
</tr>
<tr>
<td>Hwang et al.\textsuperscript{22}</td>
</tr>
<tr>
<td>Zhan et al.\textsuperscript{12}</td>
</tr>
</tbody>
</table>

* Authors explain that this figure is actually 58.3% (7/12), cause there were 4 cases of the DP series with malignant lesion, where splenopancreatectomy was planned and performed.

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between robotic, laparoscopic and open procedures, Daouadi et al.\textsuperscript{24} state that ‘among patients with pancreatic adenocarcinoma, 36\% of laparoscopic group (5/14) had microscopically positive pancreatic transection margins compared with zero (0/13, \(P < 0.005\)) in the robotic group’. This team also found a more favourable lymph node account for the robotic group (19 vs. 9, \(P < 0.01\)).

Oncological results are satisfying with acceptable R0 resection and optimal number of lymph node harvested. Nevertheless, long-term outcomes are still missed.

**Spleen preservation:** The greatest advantage attributed to robotic assistance in minimally invasive DP is related to spleen preservation. Giulianotti et al.\textsuperscript{9} stated that ‘the robotic technique allows the surgeon to individualize the branches of both the splenic artery and the vein and to selectively suture ligate them precisely and in a very controlled environment’. Hwang et al.\textsuperscript{21} evaluated their clinical experience with robot-assisted spleen-preserving DP and concluded that it is a safe and effective option for splenic preservation. Zhan et al.\textsuperscript{12} agree with both after getting a rate of spleen-preserving DP of 58.3\% (7/12), and explain that ‘the robotic surgery system provides stable, high definition, three-dimensional vision, tremor-damping systems and a fourth robot arm that can automatically pull up the body of stomach to expose the surgical field, all of which aid in the isolation, protection and selective ligation of the splenic vessels’ (Table 2, Table 3).

With regard to comparative studies, two groups have demonstrated higher rate of spleen preservation in DP with robotic assistance versus traditional laparoscopy\textsuperscript{23,25}. One of these teams emphasise the ability to use a vessel-preserving technique when the spleen is preserved\textsuperscript{23}.

**Cost:** There are a few reports about cost in robotic DP. Kang et al.\textsuperscript{25} found robot surgery to be more than twice the cost for the laparoscopic group, Waters et al.\textsuperscript{21} concluded that, although operative cost was higher in the robotic group, total costs demonstrated no difference between the three approaches (open, laparoscopic and robotic). This finding was associated with the significant reduction in mean postoperative LOS of the robot group compared with both laparoscopic and open groups\textsuperscript{23}.

**Central pancreatectomy**

This is a challenging technique adequate only for highly selected cases (40–45 cases published until today). This complex surgery is destined for patients with small low grade or benign tumours located in the body of pancreas.

We have identified four case series\textsuperscript{8,9,12,26}, one study comparing five robotic CP to 10 open CPs\textsuperscript{27} and a number of case reports.

**Intraoperative and postoperative outcomes:** Zureikat et al.\textsuperscript{8}, to our knowledge, is the largest published series of CP, with 13 cases. Their wide experience has been published recently as ’250 robotic pancreatic resections’ (Table 2, Table 4).

Reported operative time for CP goes from 219 \(\pm\) 47.2 min\textsuperscript{12} to 432 \(\pm\) 65.7 min\textsuperscript{27}. Blood loss ranges from 158 \(\pm\) 107.4\textsuperscript{12} to 432 \(\pm\) 65.7 mL\textsuperscript{27}. In the Kang et al.\textsuperscript{27} comparative study, operative time was significantly longer and bleeding amount was significantly inferior in the robotic group. Conversion rate was null for three authors\textsuperscript{9,12,27}, whereas 11\% and 15\% for the other two, respectively\textsuperscript{8,26}.

LOS varies largely between the case series. The shortest is 8 days\textsuperscript{6–19} and the longest 26.3 \(\pm\) 9.5 days\textsuperscript{12}. Kang et al.\textsuperscript{27} reports 14.6 days in the robotic group versus 22.1 in the open one, nevertheless this is not a significant difference.

Coming to complications, pancreatic fistula is the most frequent and its appearance has been considered in all the reports. Zureikat et al.\textsuperscript{8} classify pancreatic fistulae according to

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**Table 4 Case series central pancreatectomy**

<table>
<thead>
<tr>
<th>Author/year (reference)</th>
<th>(n)</th>
<th>Intraoperative outcomes</th>
<th>Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Operative time (min)</td>
<td>Blood loss (mL)</td>
</tr>
<tr>
<td>Zureikat et al.\textsuperscript{8}</td>
<td>13</td>
<td>394 (\pm) 92*</td>
<td>–</td>
</tr>
<tr>
<td>Zhan et al.\textsuperscript{12}</td>
<td>10</td>
<td>219 (\pm) 47.2*</td>
<td>158 (\pm) 107.4*</td>
</tr>
<tr>
<td>Abood et al.\textsuperscript{26}</td>
<td>9</td>
<td>425 (305–506)**</td>
<td>187 (50–350)**</td>
</tr>
<tr>
<td>Giulianotti et al.\textsuperscript{9}</td>
<td>3</td>
<td>320</td>
<td>233</td>
</tr>
</tbody>
</table>

*Mean±SD **mean (range)
the International Study Group on Pancreatic Fistula criteria (Bassi et al. Surgery 2005;138:8–13). They publish 92% of fistula rate after robotic CP, with 15% grade A (minor fistulae), 69% grade B (requiring prolonged drainage) and 8% grade C (requiring major re-intervention)\(^8\). Zhan et al.\(^8\) believe that the pancreatic stump, rather than the pancreaticogastrostomy, is the likely cause of the relatively high rate of pancreatic leakage in their study (70% after CP).

Nevertheless, all these fistulae were A level, which could be treated conservatively with drainage. In a series of nine CPs, Abood et al.\(^8\) found seven patients who developed pancreatic fistula (78%), but only two leaks (22%) were clinically relevant.

**Other procedures**

Other robotic pancreatic procedures that have been reported include total pancreatectomy\(^8,11,15\), Beger procedure\(^12\), Appleby and Frey resections\(^8\).

**Discussion**

At the moment, the literature seems to support that complex pancreatic resections are feasible and safe by a robotic approach. Nevertheless, most of published studies are retrospective with small simple size, selected patients with different diagnosis and techniques, and starting their learning curve in many cases.

One of the latest reports on this matter is a systematic review and meta-analysis of studies comparing the safety and efficacy of robotic pancreatectomy versus open pancreatectomy. Analysing the results of 137 robotic and 203 open surgeries, reported in five articles and two conference abstracts, their results of 137 robotic and 203 open pancreatectomy. Analysing the results of robotic pancreatectomy versus open pancreaticoduodenectomy (Table 2). No prospective randomised studies have been reported till now. In spite of these limitations, this review has found, as others, that the outcomes of RPD are encouraging in terms of safety and feasibility, not increasing morbidity or mortality incidence based on open surgery, and allowing patients to benefit from minimally invasive surgery postoperative advantages\(^29,30\). Otherwise, we agree with other authors that oncological results remain poorly clear, mainly due to short follow-up\(^29\).

Four case series (Table 3) and four comparative studies (Table 2) compose the utmost evidence on robotic DP. In this instance, comparison with laparoscopic approach adds interesting, although not conclusive, information. Spleen preservation seems to be the real interest of robotic pancreatic surgery, according to most of the authors\(^29,30\). Otherwise, there are two studies evaluating the cost of robotic distal pancreatectomy with contradictory results\(^23,25\).

**Conclusion**

After around 10 years of international experience, robotic pancreatic surgery can be considered as safe and efficient, or even superior, to open pancreatectomy. Robotic approach seems to enlarge the number of patients to benefit from minimally invasive surgery. Specific advantages mentioned in the literature are related to blood loss, hospital stay, overall complication rate and the rate of spleen preservation in DPs. Nevertheless, further randomised and controlled studies are needed to support the growth of robotic pancreatic surgery, mainly when addressing oncological indications.

**Abbreviations list**

CP, central pancreatectomy; DP, distal pancreatectomy; LOS, length of stay; RPD, robotic pancreaticoduodenectomy.

**References**

Review

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