

ORIGINAL ARTICLE

Significance of Two Experienced Pancreatic Surgeons Cooperating in Pancreatoduodenectomies

Bergthor Björnsson, Pernilla Benjaminsson Nyberg, Kristina Hasselgren, Ingvar Halldestam, Thomas Gasslander, Per Sandström

Department of Surgery and Department of Clinical and Experimental Medicine, Linköping University, Linköping, Sweden

ABSTRACT

Aim To investigate if two experienced pancreatic surgeons improves outcome compared to one experienced pancreatic surgeon together with junior assistant. **Methods** A retrospective analysis of 170 consecutive pancreatoduodenectomies carried out in a four year period was performed. Operation duration, blood loss, complication rate and severity according to Clavien-Dindo score, hospital stay, intensive care unit stay, mortality (in-hospital and 90 day) and oncological completeness (lymph node count and surgical margins) were evaluated separately for patients operated by one or two experienced pancreatic surgeons. Continuous data was analyzed with Mann Whitney U test and categorical data was analyzed with χ^2 square test. **Results** Operations carried out by two pancreatic surgeons (n=99) lasted 290 (111-613) minutes compared to 353 (195-817) when done by one (n=71) (p<0.001). Moderate to severe complications (\geq grade 3a) were found in 23 (23%) of patients operated by two pancreatic surgeon compared to 28 (39%) of those operated by one (p=0.023). Post-operative pancreatic fistula was found in 13 (13%) and 20 (28%) of patients operated by two and one pancreatic surgeons respectively (p=0.014). Patients operated by two experienced surgeons had a total of 39 days (3%) of the total hospital stay (1343 days) in intensive care unit compared to 67 of 990 (7%) in the other group (p<0.01). No difference was found in blood loss, hospital stay, post-operative mortality or oncological completeness. **Conclusion** Two experienced pancreatic surgeons perform pancreatoduodenectomy faster than does one with less complications and post-operative pancreatic fistula as well as reduced need for intensive care unit stay.

INTRODUCTION

Pancreatoduodenectomy, Whipple procedure, is still associated with high morbidity although the achievements of the last decades have reduced the morbidity substantially. The prognoses of most of the patients operated upon with this procedure is still dismal and therefore it is of great importance to reduce morbidity as much as possible. Mortality and hospital cost are also factors that are of significance and the centralization of pancreatic surgery to high volume centers in many countries has been motivated by reduced morbidity and mortality as well as lowered costs.

Already in the 1990s (patient cohort from the late 1980s) hospital volume was shown to affect the mortality after Whipple procedure and total pancreatectomies [1]. Regarding mortality and pancreatoduodenectomy this relationship was also shown in the elderly population [2].

Mortality was shown to be five times higher in hospitals performing less than 10 operations each year compared to hospitals performing more than 81 operation per year. A similar association was found in individual surgeons volume, this however disappeared when hospital case load was taken in account [1]. In a later analysis increased surgeon volume was however found to be related to lower mortality, shorter hospital stay and reduced cost independent of hospital volume [3]. This finding was further supported by data indicating that the total experience of the surgeon but not annual volume was important for short term outcome [4].

Early observations from the USA are further supported by more recent studies from other countries. In Belgium the mortality risk was found to be inversely related to hospital volume although a clear cut offs could not be established [5]. In an Italian study using arbitrary cut offs for hospital volume similar results were found [6]. An additional study with arbitrary set, different cut offs shows that the relationship holds true in the Netherlands as well [7]. The same relationship between hospital stay, mortality, cost and case load has been shown also in a large Japanese analysis of over ten thousand pancreatoduodenectomies [8].

Despite the evidence supporting the positive effect of both hospital and surgeon volume on short term outcomes of Whipple procedures the literature on the learning curve of the procedure is surprisingly scant. Improvement can

Received March 07th, 2016 - Accepted May 08th, 2016
Keywords complications; Pancreatoduodenectomy; Pancreatic Neoplasms
Abbreviations ICU intensive care unit; POPF Post-operative pancreatic fistula
Correspondence Bergthor Björnsson
Department of Surgery and Department of Clinical and Experimental Medicine
Linköping University, 581 85 Linköping
Sweden
Phone +46 (0)101030000
Fax +46 (0)101033570
E-mail bergthor.bjornsson@liu.se

be expected at least up to 60 procedures but the learning process is likely to continue [9].

Even though the Whipple operation is a complex surgical procedure where the experience of more than just the leading surgeon could be of importance, the literature reveals little about the eventual effect of other participants in the procedure. One study has looked at the effect of resident experience on outcomes of Whipple procedures and found, similarly to the learning curve that outcomes improve with increased resident experience [10]. This may indicate that the total experience of the surgeons performing the operation may have an impact on the surgical outcome.

The aim of this study was therefore to compare short term outcomes after Whipple procedures performed by one experienced pancreatic surgeon together with assistant to procedures performed by two cooperating experienced pancreatic surgeons.

MATERIAL AND METHODS

Pancreatic procedures in Sweden are prospectively registered in the national pancreas register. A cohort including all patients operated on with Whipple procedure during the period 2011-2014 in the surgical department at Linköping university hospital was analyzed. The department covers about one million inhabitants. Where data from the register was incomplete a retrospective completion from patients' records was performed.

A total of 170 patients were identified and included in the analysis. Patients receiving vascular resection (37,22%) were included as were patients operated on with resections of other organs than those included in Whipple operation (13,8%). Table 1 shows the demographic data.

Experienced pancreatic surgeon was defined as a surgeon capable of performing Whipple's procedure without the assistance of another surgeon fulfilling the criteria and regularly performing pancreatic surgery (participating in at least 20 procedures each year). Assisting surgeons were either trainees or general surgeons with experience of pancreatoduodenectomies through earlier participation in the procedure as second assistants.

Intraoperative data (duration of surgery, bleeding) as well as postoperative data (hospital stay and intensive care unit (ICU) stay) and complications ($\geq 3a$ according to the Clavien-Dindo, classification) was sampled. Occurrence of post-operative pancreatic fistula (POPF) according to established criteria was registered [11]. In addition data related to the oncological completeness (radicality and number of lymph nodes examined) of the operations was sampled.

Statistics

Data is presented as median (range), statistical analysis were performed with IBM SPSS Statistics version 22 (IBM Corporation, Armonk, NY, USA), a p value of <0.05 was considered statistically significant. Continuous data

was analyzed with Mann Whitney U test and categorical data was analyzed with χ^2 square test. Multiple linear regression was performed for continuous variables found to be significant at univariable testing and multiple logistic regression for categorical variables.

RESULTS

Seventy-one (42%) of the patients were operated upon by one experienced pancreatic surgeon (group 1) while the remaining 99 (58%) was operated by two (group 2). The patients in group 1 were 71 years (28-84) while the patients in group 2 were 67 years (33-84) ($p=0.01$). Other demographic factors were similar between the groups (**Table 1**).

Operations in group 2 lasted 290 (111-613) min while in group 1, the operations lasted 353 (195-817) min ($p<0.001$). Operation time was further analyzed using multiple linear regression and in addition to number of experienced pancreatic surgeons ($p<0.001$) lower BMI ($p=0.001$), female gender ($p=0.002$) and absence of extended resection ($p<0.001$) was found to be associated with shorter operation duration. No difference was noted between the groups in estimated blood loss, hospital stay, rate of non-radical surgery (R1) or the number of lymph nodes assessed (**Table 2**).

Intensive care unit (ICU) stay was 3% of total hospital stay in group 2 compared to 7% in group 1 ($p<0.01$). This significance was however not seen on multiple linear regression model ($p=0.081$) with increasing age reducing the need for ICU stay ($p=0.054$) while BMI ($p=0.693$), gender ($p=0.365$), extended resections ($p=0.223$) blood loss ($p=0.85$) and POPF ($p=0.319$) did not significantly affect the need for ICU stay.

Moderate to severe complications $\geq 3a$ (according to Clavien-Dindo classification) were found in 23 (23%) of the patients in group 2 while 28 (39%) of the patients in group 1 experienced complications of same degree ($p=0.023$). On multiple logistic regression there was a strong tendency towards statistical significant difference ($p=0.063$) while ASA class was significantly associated with occurrence of complications ($p=0.015$) but gender ($p=0.138$), age ($p=0.205$), BMI ($p=0.43$) and extended resections ($p=0.219$) was not associated with moderate to severe complications. POPF (any grade) was found in 13 (13%) patients in group 2 compared to 20 (28%) in group 1 ($p=0.014$). This difference was sustained ($p=0.002$) in a multiple logistic regression model and in addition lower age ($p=0.027$) and higher BMI ($p=0.028$) was associated with POPF while ASA class ($p=0.325$), gender ($p=0.788$), operation duration (0.525) and extended resections ($p=0.406$) was not.

The 90-day mortality in the cohort was 2.9% without any difference noted between the two groups.

DISCUSSION

This is the first study to investigate if the cooperation of two experienced pancreatic surgeons during a

Table 1. Demographic data for 170 patient operated with Pancreatoduodenectomy procedure by either one or two experienced pancreatic surgeons.

	All patients n=170	Single surgeon n=71 (group 1)	Two surgeons n=99 (group 2)	p
Gender male/female	82/88	34/37	51/48	0.64
Age median (range)	70 (28-84)	71 (28-84)	67 (33-84)	0.01
Tumor size (mm)	30 (10-90)	30 (10-90)	30 (10-90)	0.47
Extended resections	40 (24%)	17 (21%)	33 (29%)	0.19
BMI	24.7 (16-38.8)	24.8 (19.7-36.4)	24.6 (16-38.8)	0.78
ASA (1/2/3/4)	50/91/28/1	21/37/13/0	29/54/15/1	0.71

Table 2. Results after Pancreatoduodenectomy operations performed by either one or two experienced pancreatic surgeons.

	All patients n=170	Single surgeon n=71 (group 1)	Two surgeons n=99 (group 2)	p
Operation duration (min)	315 (111-817)	353 (195-817)	290 (111-613)	<0.001
Blood loss (mL)	500 (25-6500)	500 (25-2600)	500 (50-6500)	0.6
Hospital stay (days)	9 (4-107)	9 (4-107)	9 (4-99)	0.24
R1 resections, n (%)	31 (18)	12 (17)	19 (19)	0.7
Lymph nodes assessed	14 (1-48)	13 (1-40)	15 (1-48)	0.88

pancreatoduodenectomy, carried out in a high volume center, has implications for the outcome. Despite low number of patients the study shows shorter operation time, less complications including POPF and reduced need for ICU treatment without negative influence on the oncological outcomes. The overall results are comparable to other published study from similar geographical and ethnical settings, with similar proportion of extended resections while operation time and perioperative blood loss as well as 90-day mortality seems to be lower in our study [12].

As may be expected operations carried out by two experienced pancreatic surgeons were performed faster than those performed by one. Earlier, large registry study has shown correlation between operation time and 30-day morbidity and the duration of surgery is associated with complication rate (anastomosis leakage) in bowel surgery [13, 14]. The data presented herein seems to support this finding despite the low patient number included and the difference noted in POPF frequency could have been related to reduced operation duration but this was not confirmed with the logistic regression. While there was no difference in ASA grade between the groups the patients operated by one pancreatic surgeon were older than those operated by two and this could also explain some of the difference in complication rate. However, this was not confirmed with logistic regression and it seems likely that shortening of duration of surgery without impairment in the oncological outcome is of advantage for the patients.

Transfusions have been found to be risk factors for complications after pancreatic surgery, in this study it was found that addition of further experience to the surgical procedure did not reduce blood loss suggesting that other factors are important for the reduced complication rate observed [14].

No difference was found in the surrogate markers (radicality and lymph node count) for oncological outcome. A pancreatoduodenectomy without additional complicating factors is a rather standardized operation

and thus this indicates that the completeness of surgery is not increased by the additional experience.

The results have implications for the training of future pancreatic surgeons; while it is apparent that having two experienced pancreatic surgeons cooperating in pancreatoduodenectomies improves the short term outcome it is important to secure the future of this complex surgery. The selection of one or two experienced pancreatic surgeons at our unit depends on the anticipated difficulties of the procedure, e.g. expected vascular resections are performed by 2 experienced surgeons. This constitutes the main weakness of this study as the groups are not randomized and therefore there is an inherent risk of selection bias in this cohort. In order to assure that future pancreatic surgeons get trained in pancreatoduodenectomies operations without anticipated complicating factors should be scheduled for fellows and additional experienced pancreatic surgeon should be available if needed.

In conclusion this study has shown that two experienced pancreatic surgeons perform pancreatoduodenectomy faster and safer than does one pancreatic surgeon with less observed complications and reduced need for ICU stay. This adds further support to the centralization of pancreatic surgery to HPB centers only where additional experienced pancreatic surgeon can be available.

Author Contributions

Björnsson B, Halldestam I, Gasslander T and Sandström S designed the research; Björnsson B, Benjaminsson Nyberg P, Hasselgren K and Halldestam I performed the research; Björnsson B and Benjaminsson Nyberg P analyzed the data; Björnsson B wrote the paper and all authors critically revised the manuscript for important intellectual content.

Conflict of interest

The authors have no conflict of interest to declare.

References

1. Lieberman MD, Kilburn H, Lindsey M, Brennan MF. Relation of perioperative deaths to hospital volume among patients undergoing pancreatic resection for malignancy. *Ann Surg* 1995; 222:638-45. [PMID: 7487211]
2. Birkmeyer JD, Finlayson SR, Tosteson AN, Sharp SM, Warshaw AL, Fisher ES. Effect of hospital volume on in-hospital mortality with pancreaticoduodenectomy. *Surgery* 1999; 125:250-6. [PMID: 10076608]
3. Rosemurgy AS, Bloomston M, Serafini FM, Coon B, Murr MM, Carey LC. Frequency with which surgeons undertake pancreaticoduodenectomy determines length of stay, hospital charges, and in-hospital mortality. *J Gastrointest Surg* 2001; 5:21-6. [PMID: 11309644]
4. Schmidt CM, Turrini O, Parikh P, House MG, Zyromski NJ, Nakeeb A, Howard TJ, et al. Effect of hospital volume, surgeon experience, and surgeon volume on patient outcomes after pancreaticoduodenectomy: a single-institution experience. *Arch Surg* 2010; 145:634-40. [PMID: 20644125]
5. Topal B, Van de Sande S, Fieuids S, Penninckx F. Effect of centralization of pancreaticoduodenectomy on nationwide hospital mortality and length of stay. *Br J Surg* 2007; 94:1377-81. [PMID: 17657717]
6. Balzano G, Zerbi A, Capretti G, Rocchetti S, Capitano V, Di Carlo V. Effect of hospital volume on outcome of pancreaticoduodenectomy in Italy. *Br J Surg* 2008; 95:357-62. [PMID: 17933001]
7. de Wilde RF, Besselink MG, van der Tweel I, de Hingh IH, van Eijck CH, Dejong CH, Porte RJ, et al. Impact of nationwide centralization of pancreaticoduodenectomy on hospital mortality. *Br J Surg* 2012; 99:404-10. [PMID: 22237731]
8. Yoshioka R, Yasunaga H, Hasegawa K, Horiguchi H, Fushimi K, Aoki T, Sakamoto Y, et al. Impact of hospital volume on hospital mortality, length of stay and total costs after pancreaticoduodenectomy. *Br J Surg* 2014; 101:523-9. [PMID: 24615349]
9. Tseng JF, Pisters PW, Lee JE, Wang H, Gomez HF, Sun CC, Evans DB. The learning curve in pancreatic surgery. *Surgery*. 2007; 141:694-701. [PMID: 17511115]
10. Relles DM, Burkhart RA, Pucci MJ, Sendecki J, Tholey R, Drueding R, Sauter PK, et al. Does resident experience affect outcomes in complex abdominal surgery? Pancreaticoduodenectomy as an example. *J Gastrointest Surg* 2014; 18:279-85. [PMID: 24222321]
11. Bassi C, Dervenis C, Butturini G, Fingerhut A, Yeo C, Izbicki J, Neoptolemos J, et al. Postoperative pancreatic fistula: an international study group (ISGPF) definition. *Surgery* 2005; 138:8-13. [PMID: 16003309]
12. Ansoorge C, Nordin JZ, Lundell L, Strömmer L, Rangelova E, Blomberg J, Del Chiaro M, et al. Diagnostic value of abdominal drainage in individual risk assessment of pancreatic fistula following pancreaticoduodenectomy. *Br J Surg* 2014; 101:100-8. [PMID: 24306817]
13. Lipska MA, Bissett IP, Parry BR, Merrie AE. Anastomotic leakage after lower gastrointestinal anastomosis: men are at a higher risk. *ANZ J Surg* 2006; 76:579-85. [PMID: 16813622]
14. Ball CG, Pitt HA, Kilbane ME, Dixon E, Sutherland FR, Lillemoe KD. Peri-operative blood transfusion and operative time are quality indicators for pancreatoduodenectomy. *HPB (Oxford)* 2010; 12:465-71. [PMID: 20815855]