ORIGINAL ARTICLE

Professionalization of surgical abdominal organ recovery leading to an increase in pancreatic allografts accepted for transplantation in the Netherlands: a serial analysis

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SUMMARY

Professional abdominal organ recovery with certification has been mandatory in the Netherlands since 2010. This study analyses the effects of certification (January 2010–September 2015) on pancreas transplantation and compares it to an era before certification (February 2002–May 2008) for surgical injuries and the number of pancreases transplanted. A total of 264 cases were analysed. Eighty-four recovered pancreases (31.8%) with surgically injuries were encountered. Forty-six of those were surgically salvaged for transplantation, resulting in a total of 226 (85.6%) being transplanted. It was found that certified surgeons recovered grafts from older donors (36.8 vs. 33.3; $P = 0.021$), more often from donation after circulatory death (DCD) donors (18% vs. 0%; $P < 0.001$) and had less surgical injuries (21.6% vs. 41.0%; $P < 0.001$). Certification (OR: 0.285; $P < 0.001$) and surgeons from a pancreas transplant centre (OR: 0.420; $P = 0.002$) were independent risk factors for surgical organ injury. Predictors for proceeding to the actual pancreas transplantation were a recovering surgeon from a pancreas transplantation centre (OR: 3.230; $P = 0.003$), certification (OR: 3.750; $P = 0.004$), donation after brain death (DBD) (OR: 8.313; $P = 0.002$) and donor body mass index (BMI) (OR: 0.851; $P = 0.023$). It is concluded that certification in abdominal organ recovery will limit the number of surgical injuries in pancreas grafts which will translate in more pancreases available for transplantation.

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Key words
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Introduction

There remains a reticence on accepting less than perfect pancreas allografts for transplantation among many transplantation surgeons. This is because of the potentially high complication rate associated with pancreas transplantation and the misconception of absent survival benefit [1–3]. However, it is always on the back table where the final decision has to be made by the transplant surgeon whether or not to proceed with the transplantation. Overall organ quality, aspect of parenchyma, vascular damage and reconstruction possibilities are carefully

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taken into account weighing the benefits against the involved risks of transplantation [4]. The margin of error is very limited when dealing with a pancreas allograft, and it is therefore dependent on the organ recovery quality. Limiting iatrogenic damage and adequate perception of a usable graft is paramount in the final acceptance of a pancreas allograft for transplantation.

Thomas Starzl first standardized the multi-abdominal organ recover technique in 1987 [5,6]. This technique is still the reference by which most surgeons do organ recovery today albeit with some modifications [4,7]. Training in abdominal organ recovery is mainly on a master-apprentice base at the same working hospital in many countries and was also the case in the Netherlands before 2010. This leads inevitable to a wider variability of organ recovery quality, especially if the senior surgeons involved are not trained in transplantation. A recent study, analysing surgical graft injuries in pancreatic allografts, showed that there were higher chances of refusal if the recovering surgeon did not come from a centre with pancreas transplantation experience. It was suggested that more training in pancreas recovery with annual feedback was needed to achieve a drop in refusal rate [8]. Similarly, a qualitative study from Germany conducted over 14 transplant centres performing more than five pancreas transplantation per year showed that transplant surgeons were more inclined to refuse pancreas grafts from a surgeon who has limited experience in pancreas transplantation [2]. During the third WHO Global Consultation on Organ Donation and Transplantation in 2010, it was urged to standardize best common practise in organ recovery. This was advised to enlarge the donor pool and organ yield, taking seriously into account the increased number of patients on the waiting list [9]. Because of these reasons, a compulsory training with certification and accreditation of abdominal organ recovery surgeons in the Netherlands became a mandatory requirement in 2010 for all surgeons who were involved with abdominal organ recovery. The curriculum as set by the Dutch Transplantation Foundation consists of an e-learning module [10], participation of a 2-day master class [11], a mandatory surgical logbook [12] and on the spot practical examination [13]. Without this certification, surgeons are not allowed to independently recover abdominal organs from deceased donors in the Netherlands since 2010.

The aim of this study was to retrospectively compare the quality of pancreas recovery after certification with a historical group before the certification [8] and to determine predictors for surgical injury and pancreas transplantation.

Methods

Training and certification

The e-learning module is designed by the collaborate efforts of the Leiden University Medical Centre, the University Medical Centre Groningen and the Dutch Transplant Foundation. It is a step-by-step video illustrated online teaching programme starting from donor preparation up to postprocedural debriefing. Each step is explained with instructions and anatomical illustrations about the surgical technique and exemplified with a video. At the end of each step, the trainee is tested with a multiple-choice exam. The trainee may proceed to the next step of the procedure only after given the correct answers [10]. The 2-day hands-on master-class is a yearly training course organized by the European Society for Organ Transplantation in Leiden and open to all interested surgeons. The first day composes of lectures by world experts on essential anatomy, physiology, surgical techniques and organ preservation. On the second day, participants get to practice on special prepared cadavers supervised by experts [11]. After completing these two courses, the candidate is allowed to have on the field training with a supervising certified surgeon. The trainee must keep an online logbook with minimal 10 supervised kidney, liver and pancreas recoveries before he can apply for examination. Supervisors are allowed to comment on this log and make an assessment [12]. Finally, an examination will be conducted by an independent certified examiner from another procuring centre. The certification becomes formal once the candidate has passed this examination.

Pancreas recovery technique according to the Dutch pancreas recovery protocol

The technique taught in the Netherlands has been extensively described elsewhere [7]. In short, all abdominal organs are first mobilized in the warm when possible. The bile duct is then divided and ligated close to the pancreas. After cold perfusion with UW solution, the duodenum is sterilized with 50–80 ml povidone iodine water solution mixed with amphotericin B through a nasogastric tube before duodenal, and after jejunal division. The gastroduodenal artery is tagged and transected. The length of the portal vein should be divided about 2–3 cm above the pancreatic head. The common hepatic artery is dissected proximally towards the coeliac trunk. This artery courses along the superior edge of the pancreatic head. It is imperative to take notice of a potential dorsal pancreatic artery branching off (12–24% anomaly) [14]. In case of this

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anomaly, the coeliac trunk or common hepatic artery is divided just distal of the dorsal pancreatic artery. Subsequently, the splenic artery is dissected close to its origin and tagged with a suture before transection. The SMA is dissected and carefully cut out, leaving a small aortic patch. Finally, the pancreas is mobilized out of the body using the spleen as a handle and taking care not to damage the splenic vein while detaching the pancreas from its retroperitoneal attachments. Single venous and arterial iliac grafts are also recovered with the pancreas. The organs are then packed in three separate plastic bags containing UW solution, iced Ringer lactate and no solution from inside out, respectively.

Study

Pancreas recovered, accepted and transported for transplantation to Leiden University Medical Centre from January 2010 until September 2015 were included and compared to a previous cohort from February 2002 until May 2008 [8]. Those that were initially recovered for islets transplantation were excluded for analysis.

All accepted pancreatic grafts for transplantation were first inspected by a transplant surgeon after being transported to the Leiden University Medical Centre. Quality of the recovery was reported on a pancreatic quality form. This form is used in the Netherlands as quality feedback and data registration. Problems were registered and distinguished between arterial, venous, duodenal, parenchymal quality, vascular grafts and others. The reason for refusal for transplantation is also reported. Donor age, gender and body mass index (BMI) were obtained. Furthermore, data about donor type [donation after circulatory death (DCD) or donation after brain death (DBD)], organ preservation solution used and pancreas anatomy were collected. Organ recovery centres were categorized into two regions: the Netherlands and International. Centres were categorized as whether they performed pancreas transplantation based on data obtained from Eurotransplant. This data was then used to determine whether the recovering surgeon came from a hospital with pancreas transplantation experience. The issues recorded on the pancreas quality form were categorized into critical and noncritical problems. Problems were considered critical if it resulted in an abortion of transplantation due to irreparable damage of the graft. Arterial problems were differentiated into head, neck, body and pancreatic tail. Venous injuries were localized into portal, superior mesenteric or splenic vein. Atherosclerosis was considered severe if vascular reconstruction was deemed risky for thrombosis. Also the absence of allogeneic vascular grafts was considered critical if there was no backup in house. Routinely vascular allografts not used for transplantation were stored for 2 weeks under sterile conditions in a refrigerator at a set temperature of −80 °C.

The periods were divided into a certified and a noncertified groups. The pancreas grafts that were recovered outside of the Netherlands in the second era (January 2010–September 2015) were added to the noncertified group. This is also the case for all the pancreata recovered in the first era (February 2002 until May 2008). The two groups were then compared on baseline demographics, type of donor (DCD versus DBD), amount and type of surgical issues encountered, and refusal for transplantation. The numbers of critical and noncritical problems were also compared. Univariate comparative analysis was carried out using chi-square or Fisher exact test when appropriate for categorical variables. For continuous variables, *t*-test was used if they followed the normal distribution; otherwise, the Mann–Whitney *U*-test was used. Predictors for surgical injury and proceeding to pancreas transplantation, respectively, were found using a multivariate logistic regression analysis with backward elimination method of independent variables that were suspected to influence these outcomes with a *P*-value under 0.200. A *P*-value of less than 0.05 was considered significant. For the statistical analysis, IBM SPSS STATISTICS 23.0 software was used.

Results

A total of 264 accepted pancreases were inspected of which 226 (85.6%) were transplanted in the end. Eighty-four (31.8%) had surgical injuries of which 46 (54.7%) could be salvaged for transplantation. The mean donor age was 35 years (SD 12.5 years), and mean BMI was 23 (range 15–31). The majority of the pancreases were recovered in the Netherlands (88.6%) with only 11.4% being imported from other countries within the Eurotransplant region (Table 1). Between January 2010 and September 2015, there were five pancreas allografts imported from abroad. These were added to the first cohort (February 2002 until May 2008) to make up the group of 139 (52.7%) pancreas allografts recovered by noncertified surgeons. The study group consisted of the grafts recovered by surgeons who underwent training, examination and certification and were labelled as 'certified'. This group included 125 (47.3%) cases.

When comparing both groups, the certified group had older donors (36.8 years vs. 33.3 years; $P = 0.021$), included less DBD donors (82% vs. 100%; $P < 0.001$) and had a lower incidence of surgical injuries encountered on the back table (21.6% vs. 44.1%; $P < 0.001$). This did not translate in a significant difference in abortion of pancreas transplantation (certified: 11.2% vs. noncertified: 17.3%;

Table 1. Pancreas allograft accepted and inspected at the back table (n = 264; Leiden University Medical Centre, February 2002–May 2008 and January 2010–September 2015).

Mean age	35 years (SD ± 12.5)
BMI	23 (15–31)
Surgical injuries	84 (31.8%)
Transplanted	226 (85.6%)
Region	
The Netherlands	234 (88.6%)
International	30 (11.4%)

P = 0.161). BMI was similar between the two groups (certified: 23.4 vs. noncertified: 23.16; P = 0.525) (Table 2). Ninety-six critical injuries were encountered in the 38 pancreases refused for transplantation. Of those with critical injuries, the majority had only one critical problem (n = 13; 34.21%) while the remaining had up to six critical injuries. There was no significant difference in mean number of critical problems between the two groups (certified: 0.23 vs. noncertified 0.48; P = 0.131). The most common critical problem encountered in the grafts with critical problems was severe injury to the parenchyma (n = 30; 31.25% of all critical problems). The only difference in critical problems encountered between the two groups was that the certified group had less often injuries to the splenic vein (0.8% vs. 6.5%; P = 0.021) (Table 3).

Forty-six pancreas allografts with 54 noncritical problems were salvaged for transplantation, ranging from 1 to 5 per pancreas. Most of these had only one noncritical problem (n = 41; 89.13% of all noncritical problems). There was a lower mean number of noncritical problems encountered in the certified group (0.14 vs. 0.4, respectively; P < 0.001). Noncertified surgeons cut the portal vein shorter (0.8% vs. 6.5%; P = 0.021) and used less duodenal decontamination with povidone iodine (0% vs.

Table 3. Differences between certified and noncertified groups on type of surgical problems encountered during back-table inspection (Leiden University Medical Centre, February 2002–May 2008 and January 2010–September 2015).

	Certified (n = 125)	Noncertified (n = 139)	P
Mean critical problems	0.23	0.48	0.131
Parenchyma	9.60%	12.90%	0.392
Arterial			
Head, neck, body pancreas	0.80%	0.70%	0.94
Tail pancreas	3.20%	6.5%	0.22
Venous			
Portal vein	1.60%	5.80%	0.108
Splenic vein	0.80%	6.50%	**0.021**
SMV	0.80%	5%	0.069
Other			
Duodenal injury	1.60%	4.30%	0.287
Severe atherosclerosis	1.60%	5%	0.178
Mean noncritical problems	0.14	0.4	**<0.001**
Parenchyma	1.60%	5%	0.178
Arterial			
Head, neck, body pancreas	0.80%	2.20%	0.624
Tail pancreas	1.60%	3.60%	0.452
Venous			
Portal vein (too short)	0.80%	6.50%	**0.021**
Splenic vein	0.00%	0.70%	0.342
SMV	0.00%	0.70%	0.342
Other			
Duodenal (no povidone)	0.00%	7.20%	**0.002**
Open CBD, no toolkit	9.60%	13.70%	0.305

P < 0.05 is considered significant.

Table 2. Demographic difference between certified and noncertified groups (Leiden University Medical Centre, February 2002–May 2008 and January 2010–September 2015).

	Certified (n = 125)	Noncertified (n = 139)	P
Mean age (years)	36.8 (10–57)	33.3 (10–50)	**0.021**
Mean body mass index (kg/m^2)	23.4 (17–29)	23.16 (15–31)	0.525
DBD	102 (82%)	139 (100%)	**<0.001**
Surgical problem	27 (21.6%)	57 (41.0%)	**<0.001**
Pancreata refused for transplant	14 (11.2%)	24 (17.3%)	0.161
Sex: male/female	2/123	71/68	**<0.001**
Pancreas transplant centre surgeon	63 (50.4%)	84 (60.40%)	0.101

P < 0.05 is considered significant.

7.2%; $P = 0.002$). Other types of noncritical problems were not different between the two groups (Table 3).

Independent predictors for surgical damage to the pancreatic graft were certification (OR: 0.285; CI: 0.153–0.532) and a recovering surgeon from a pancreas transplant centre (OR: 0.420; CI: 0.242–0.731) (Table 4). Predictors for pancreas transplantation after back table assessment included certification (OR: 3.750; CI: 1.507–9.330), DBD (OR: 8.313; CI: 2.241–30.831), BMI (OR: 0.851; CI: 0.741–0.978) and a recovering surgeon from a pancreas transplant centre (OR: 3.230; CI: 1.510–6.912) (Table 5).

Discussion

This study showed that certification of surgeons for abdominal organs recovery has a positive impact on pancreatic graft quality. The adequate knowledge and standardization of the procedure results in a significant reduction of surgical problems encountered on the back table. This in turn led to an increased number of pancreases transplanted. To our knowledge, this is the first study analysing the impact of systematic training and examination on recovery injuries in pancreatic grafts.

The positive impact of certification is explained by the unique way abdominal organ recovery is taught in the Netherlands. First of all, by introducing an e-learning module, candidates can progress at their own pace and reuse it as reference. The online format makes it easy accessible and permanently available. Furthermore, this module also ensures a standard way of organ recovery by only allowing a candidate to progress to the next step of the procedure once the prior step is fully understood [10]. The yearly 2-day master-class is an addition and not a substitute to the e-learning module because it also provides a platform to discuss the specifics of organ recovery with experts in the field of transplantation and other peer colleagues. Not only tips and tricks are exchanged, but discussions about pearls and pitfalls are elaborated. It is also the first encounter to put theory into practice without clinical consequences as cadavers are prepared to simulate a real case [11]. The compulsory number of 10 supervised organ recoveries (minimal 10 kidneys, 10 pancreas and 10 liver recoveries) is set as a standard by The Dutch Transplantation Foundation. This number is much less than the American Society of Transplant Surgeons (ASTS) requirements of 25 organ recoveries [15]. The exact number needed for adequate exposure is difficult to determine and that is why commentary by the certified supervisor plays an important role in the final judgement of the individual trainee [12]. The ASTS abdominal fellowship programme in the USA has a similar programme with an online e-learning curriculum, on the field supervised training and a logbook. But it lacks an independent examination to assess the quality of the organ recovery [15,16]. This makes the Dutch certification process unique according to our knowledge. For the examination to be unbiased, a certified surgeon from another centre is always chosen as an examiner. This form of certification pathway has been met with much enthusiasm by other countries within the Eurotransplant region [17].

Surgical injury of abdominal organs is also found in liver and kidney recovery. The incidence during a

Table 4. Risk factors for surgical problems of the pancreas allograft at the back table (Leiden University Medical Centre, February 2002–May 2008 and January 2010–September 2015).

	Coefficient	OR	95% CI	*P*
Certification	−1.254	0.285	0.153–0.532	**<0.001**
Pancreas transplant centre	−0.867	0.420	0.242–0.731	**0.002**
DBD	−0.942	0.390	0.141–1.075	0.069

$P < 0.05$ is considered significant.

Table 5. Predictive factors for pancreas transplantation after back table inspection of the pancreas allograft (Leiden University Medical Centre, February 2002–May 2008 and January 2010–September 2015).

	Coefficient	OR	95% CI	*P*
Certification	1.322	3.750	1.507–9.330	**0.004**
DBD	2.118	8.313	2.241–30.831	**0.002**
Age (per year)	−0.030	0.970	0.938–1.004	0.083
BMI (per kg/m^2)	−0.161	0.851	0.741–0.978	**0.023**
Pancreas transplant centre	1.173	3.230	1.510–6.912	**0.003**

$P < 0.05$ is considered significant.

review in the UK registry from 2001 until 2010 accounted for 14% in liver [18] and 7.1% in kidney recovery [19]. This led to a refusal of transplants in 0.33% and 0.8%, respectively [18,19]. Livers are usually refused after initial acceptance because of a steatotic appearance. The same argument goes for kidney transplantation where poor perfusion and poor biopsy results may lead to a withdrawal as shown in a recent report from the OPTN [20]. The refusal based on surgical injury is much higher for pancreas recovery, where the incidence ranges from 16.6% to 52% with loss of transplantation in 12% up to 17.2% after the initial acceptance as described in earlier studies [8,9,21,22]. The margin of error is therefore much narrower when it comes down to pancreas recovery. This emphasizes the need for better training and examination. It is suggested by our analysis that certification and having a pancreas transplant background can further reduce these numbers. Another point is that with the progressive upsurge of DCD organ recovery, a parallel increase in injuries would be expected because of the more time challenging nature of the DCD procedure. This was not found in our analysis albeit the fact that no DCD pancreas were recovered prior to the certification era. These findings highlight even further the beneficial effect of certification on the organ quality given the increase in DCD recoveries. This finding is also supported by the UK transplant task force after installing dedicated recovering teams with the intention of limiting iatrogenic graft injuries in DCD recoveries [18,19,21].

Further differentiating the types of injuries gives a better understanding on where improvements can be made in terms of training. For instance, parenchymal damage inadvertently always led to an abortion of pancreas transplantation in our analysis. It was also the most common finding in the critical problems encountered. This was also the case in another study [21]. Damage could potentially lead to local pancreatic enzyme leak with subsequent peri-pancreatitis and abscess formation. This is a common assumption by many surgeons without much supported evidence. On the other hand, the amount of splenic vein injuries was reduced because of certification. From this, we can only assume that the correct way of mobilizing the pancreas from its retroperitoneal surroundings is taught, but despite these efforts, iatrogenic parenchymal damage remains an issue despite certification. Similarly, easily avoidable errors such as not decontaminating the duodenum and cutting the portal vein too short were less encountered as a result of certification, but an open CBD or an absent toolkit remained a common finding. These points confirm that certification has the potential to limit certain types of injuries while having less impact on other types of iatrogenic injuries. Improvements should always be made, but this is only possible if an exact analysis is made of where these common errors persist as our study has tried to analyse. Only then can improvements to the programme be made. For instance, a suggestion of double suture ligating the CBD might possibly prevent this noncritical surgical problem in the future. Additionally, there is also a need for continuous monitoring of organ quality by recovering surgeons based on yearly surgical volume with extra attention given to those with less volume or more surgical errors. A possible recertification course might be opportune for those that need more support.

A transplant surgeon's initial selection of a cadaver pancreas donor is based on known risk factors for technical complications such as age, BMI, cold ischaemia time and DCD for instance [23–26]. It was therefore surprising to find that some of these risk factors remained a predictor on turning down a graft for transplantation after inspection, even after careful donor preselection. For instance, higher BMI was a risk factor for turning down a potential graft. This could possibly be explained by a fatty appearance, but this was not analysed here. Other risk factors for turning down a pancreas graft such as certification and a recovering surgeon from pancreas transplant centre are related to the lower incidence of surgical injury encountered in this study. However, subjective selection bias because of trust issues towards the recovering surgeon can not entirely be ruled out. This is also shown to be the case in other reports [2,8]. Nevertheless, we tried to limit this by including recovering surgeons from other pancreas transplant centres in our analysis. This selection bias is also applicable to grafts from DCD donation as this was also a risk factor for turning down a pancreas after back table inspection but surprisingly not a risk factor for surgical injury. Perhaps with the background knowledge that DCD negatively influences graft survival in certain reports [26], transplant surgeons are more sceptical in judging macroscopic appearance that would not have been turned down if it had been a DBD procedure. This remains difficult to ascertain unless transplant surgeons are blinded from the type of donation procedure.

We conclude that certification as implemented by the Dutch protocol reduces but does not eliminate the amount of pancreatic allograft injury. However, surgical injury does not necessarily mean that the graft cannot be used for transplantation. Furthermore, certification has a positive influence on pancreatic grafts being

finally accepted for transplantation because of the decreased incidence of surgical problems encountered at the back table. The beneficial effects of this Dutch model needs to be further evaluated in other countries that are now implementing this in their transplantation curriculum [17].

Authorship

HDL: designed, wrote and performed the study. AFS: collected the data and contributed to the writing. WHK: helped analyse the data. HP: analysed the data. AEB: helped writing and reviewing the data. AB: designed and reviewed the article.

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Conflict of interests

The authors of this manuscript have no conflict of interests to disclose.

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