Renal Transplant Survey:

How Standardised Is A Standard Kidney Transplant?

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DECLARATION

I, JONATHAN HENRI WIGHT hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Abstract:

Aim: The primary intention of the current study was to discover if there are international standards in renal transplantation.

Method: A questionnaire was created using an online survey tool (Qualtrics ®), and distributed to a list of email addresses supplied by the unit's senior transplant surgeon. A literature review was performed on the questions and on the history of transplantation.

Ethics was approved by FHS HREC number 193/2015.

Results: A total of 30 surveys were completed from a total of 147 emails sent (20.4%). Two thirds of respondents work exclusively in the public sector and almost two-thirds (63.3%) of the respondents had been involved in transplantation for over 10 years. Two thirds of the surgeons estimate that their units perform more than 60 transplants per annum. Only 30% (9/30) use living donors in more than 50% of their surgeries. Most (53.3%) perfuse the kidneys both in the donor (in situ) and outside (ex situ or ex vivo). If no anatomic abnormalities were noted in open living donor nephrectomy, 63.3% would prefer to use the left kidney, and the recipient transplantation would be performed on the right side (76.7%). The majority (90%) of surgeons would preserve the vas deferens, but sacrifice the round ligament and inferior epigastric vessels (76.7% and 80% respectively). There is no marked difference for use of either the internal or external iliac artery for the arterial anastomosis, but most use the external iliac vein for venous anastomosis (86.7%). 80% use a ureteroneocystostomy with a tunnel, and 60% use a DJ stent or ureteric catheter and closed suction drain routinely. Two thirds would remove the transurethral catheter on day 4-7 post operatively. 80% routinely biopsy the kidney, and 63.3% would biopsy prior to treating for possible acute renal rejection.

Discussion: These results compare with some of the studies found in the literature and operative textbooks. There do appear to be standards noted between most of the respondent's answers.

Conclusion: There do appear to be standards for renal transplantation and these are appreciated globally.

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Chapter 1:

Literature Review:

History of Renal Transplantation:

Erwin Payr (1871-1946), an Austrian-German surgeon, was credited with developing the first workable vascular suturing methods (Margreiter, 2013) which have been used in transplantation. Emerich Ullmann (Austria, 1902) performed the first experimental renal transplant by placing a canine kidney into the neck of another dog – the kidney survived for 5 days (Margreiter, 2013). In 1906 Mathieu Jaboulay performed the first renal xenotransplant when he transplanted goat and pig kidneys on to the brachial vessels of two people with renal failure (Watson, 2012). These grafts reportedly survived for about an hour and were lost due to vascular thrombosis (Margreiter, 2013). Later in 1911, L.J. Hammond of Philadelphia performed the first renal allograft but he only enjoyed transient success as the transplant kidney failed (Randale, 2004). The work done by Jaboulay and Hammond was undertaken long before the characterization of the human immune system, and the introduction of immunosuppression.

Alexis Carrel (one of Jaboulay's students), while in Chicago made significant contributions to transplantation with his work in vascular anastomoses, authoring '*The Operating Technique for Vascular Anastomosis and Organ Transplantation*' in 1902 (Margreiter, 2013), and introducing the concept of cooling for organ preservation (Shackman, 1966). After transferring to the Rockefeller Institute in New York, he discovered that they were able to perform renal autografts in dogs successfully, but noted that their allografts invariably failed. He suggested that this was not a technical problem, but rather due to intrinsic differences between the dogs. He hypothesized that the "principle of immunity" might explain his observations. He suggested "that serum of the host might be injurious to the homotranplanted organ" (Shackman, 1966). As previously mentioned immunosuppression was only introduced in the latter half of the twentieth century. In 1912 he received the Nobel Prize for this work and his work on vascular sutures (the "triangulation" technique) (Jean-Paul, 2011).

Floresco, in 1905, transplanted the kidney by heterotopically anastomosing to the femoral vessels, and used a cutaneous fistula/ureterostomy for urinary drainage, with initial good outcomes (Castro, 1978).

Williamson and Ibuka (1926), at the Mayo Foundation, following on Carrel's work, developed the operative technique which is still used today for renal transplantation (Shackman, 1966).

Yu Yu Voronoy, a Ukrainian surgeon working in Kiev, performed a series of six transplants to treat mercury poison associated acute renal failure (all para suicide attempts). The renal transplants all failed, mainly due to the deleterious effect of warm ischaemia; the first kidney was retrieved 6 hours after the donor died, this was a cadaveric or non-heart beating donor nephrectomy (Watson, 2012).

Initial transplant pioneers were using cadaveric (mainly long deceased) or animal organs. Later in 1950, it was realised that the excessive cold ischaemic times should be avoided and live donors were starting to be used (Watson, 2012). On 17 June, 1950, the first deceased/cadaveric transplant in the USA was performed on Ruth Tucker, a 44 year old female with polycystic kidney disease, at the Little Company of Mary Hospital in Illinois. The kidney was rejected after 10 months due to the lack of immunosuppression. However, the renal transplant allowed her diseased kidneys time to recover and she lived for another 5 years after the renal rejection (Sharma, 2010).

In 1952, Jean Hamburger, at the Necker Hospital in Paris, performed the first living donor transplant; however, the kidney only survived for 3 weeks post procedure with good function (Legendre, 2010). Later in 1954, the first successful Living renal transplantation was performed by Joseph Murray and his team in Boston at the Peter Bent Brigham Hospital in Boston, MA. The transplant was between the twenty three year old identical twin Herrick brothers (Ronald [donor] and Richard [recipient]). Richard Herrick lived for another 8 years before developing recurrent kidney disease. The team proved that living renal transplants could be performed safely for both recipient and donor, without any immunosuppression. Ronald Herrick lived until he was 79 years old (Watson, 2012) (Jean-Paul, 2011). Unfortunately, the problem of rejection was not addressed by this and the subsequent twin transplantations, but it did serve as proof of the concept of immune based rejection. The

Nobel Prize for Medicine was bestowed on Dr Murray, in 1990 (Starlz, 2000), for this and his later transplant work.

Renal transplantation has been shown to be one of the easiest organs to procure, and living donors can be used with minimal long term complications, and with a survival that matches the normal population (Ibrahim, et al., 2009). In the case of failure, dialysis was already available after being developed by Dutch physician, Dr Willem Kolff in 1943. He is considered the father of the dialysis machine (Dunea, 2009).

Transplants after 1954 were initially limited to identical siblings, and deceased donors were used infrequently. The real breakthrough came with the introduction of chemical immunosuppression in the 1960's. The goal was to suppress the immune system enough to permit engraftment, while being specific enough not to destroy other protective immune responses (Watson, 2012). The introduction of azathioprine and steroid combination therapy to prevent rejection provided promising results from the early 1960's and later became the basis for immunosuppression, allowing one year survival of approximately 50% – this is significant in the era of early dialysis (Watson, 2012). Azathioprine was first used in 1961 at the Peter Bent Brigham Hospital (Morris, 2014), mentioned previously as the Hospital where Dr Murray performed the first successful living transplantation. The discovery of cyclosporine in the mid-1970s dramatically improved the results to the extent that most centres reported a one year survival greater than 90-95% (Watson, 2012). Further advancements in immunosuppression, including antibody based regimens (monoclonal and polyclonal) and other maintenance medications (e.g. sirolimus, tacrolimus and mycophenolate) have had a positive impact on both patient and graft survival.

Indications for transplantation:

UK statistics from 2010 show that there are about 22000 patients alive with a functioning renal transplant, and there are a further 25000 on dialysis, of whom 7000 are currently on the transplant waiting list (Watson, 2012). Renal transplantation increases survival and improves the quality of life for patients with end stage renal failure (Thirchelvam, 2011). The indication for renal transplantation is end stage renal disease (ESRD) regardless of the cause. Diabetes mellitus and hypertension make up approximately 70% of the causes of end stage renal disease, followed by glomerular diseases (glomerulonephritis, focal segmental

glomerulosclerosis, etc.), cystic kidney diseases, congenital urinary tract abnormalities (posterior urethral valve), and systemic lupus erythematosus (SLE) and other systemic diseases (vascular, infection related, and hereditary disorders) (Wein, 2012).

Most patients referred for transplantation are on dialysis (haemofiltration or peritoneal dialysis) at the time of transplantation. Some chronic renal failure patients with an appropriate donor may undergo pre-emptive transplantation prior to needing dialysis. This is associated with improved patient and allograft survival, reduced dialysis related morbidity, decreased risk of sensitisation, cost savings on dialysis, and better quality of life (Abecassis, 2008). Transplantation may even be a more cost effective alternative to dialysis, due to improvements in early graft survival and long term function (Abecassis, 2008). Survival is considerably better after transplantation compared to dialysis. Certain conditions may recur in the transplanted kidney including immunoglobulin A (IgA) nephropathy, some of the glomerulonephritides (focal segmental glomerulosclerosis), haemolytic uremic syndrome, diabetes and primary oxalosis. Patients should be counselled about risk of recurrence and secondary graft failure (Wein, 2012). However, the low recurrence rates do not preclude transplantation.

Contraindications for transplantation:

Exclusion criteria for renal transplantation include poor medical baseline (untreatable cardiovascular disease, severe chronic obstructive pulmonary disease and cor pulmonale, severe systemic amyloidosis, obesity, peripheral arterial/vascular disease), active malignancy or infection, life expectancy <2 years (unlikely to improve with transplantation), uncontrolled psychosis or psychiatric disorders, active substance abuse, and immunologic barriers (such as a positive T-cell crossmatch) (Hakim, 2012) (Karam, 2009). These are contraindications as the patients are not suitable for a long anaesthetic and surgical procedure due to their cardiac, pulmonary and/or hepatic insufficiency. Obesity used to be a relative contraindication to renal transplantation (Kälble, et al., 2005), however it is now no longer considered an absolute contraindication (Marks, 2004). Most transplant programs have age limits and require good health (excluding the renal failure) for a recipient to be on the waiting list. To reduce the risk of cancer recurrence, a waiting period of 2-5 cancer free years from last treatment has been recommended for invasive malignancy (Wein, 2012).

Noncompliance with dialysis program or failure to complete a contract of compliance and inability to perform rehabilitation are unacceptable conditions for transplantation.

Acquired immunodeficiency syndrome (AIDS: Centre for Disease Control defined as CD4 <200cells/mm^3) is also an exclusion. Different circumstances apply when a recipient is already infected with HIV or hepatitis and transplant from infectious donors is possible in certain situations (Karam, 2009). However if an HIV positive individual with a CD4 >200cells/mm^3 for >6months, on HAART for >3months, HIV RNA negative, and no major infectious/neoplastic complications may be accepted for transplantation. The transplantation of HIV-positive donor kidneys to HIV-infected recipients is now a viable alternative to chronic dialysis or transplantation from HIV negative donors (Muller, 2012).

Organ donation:

Transplant donors are either living or deceased (formerly cadaveric) donors (figure 1). Living donors are divided into living related (genetically similar) or living unrelated depending on whether or not a biological relationship exists between the donor and recipient. Deceased donors are divided into heart beating kidney donors [HBKD] (or brain dead), and non-heart beating kidney donors [NHBKD] (or donation after cardiac death [DCD] donors), dependant on whether they meet criteria for brain death and if the heart is still beating at this stage (Wein, 2012). With immunosuppression being so effective, living donors no longer need to be genetically similar, and most kidneys today come from deceased donors. “In an effort to address the widening gap between demand and supply of donor organs, there has been an increase in the numbers of live donors, such that there are now more live donors than deceased donors per year in the UK, as there are in the USA” (Watson, 2012).

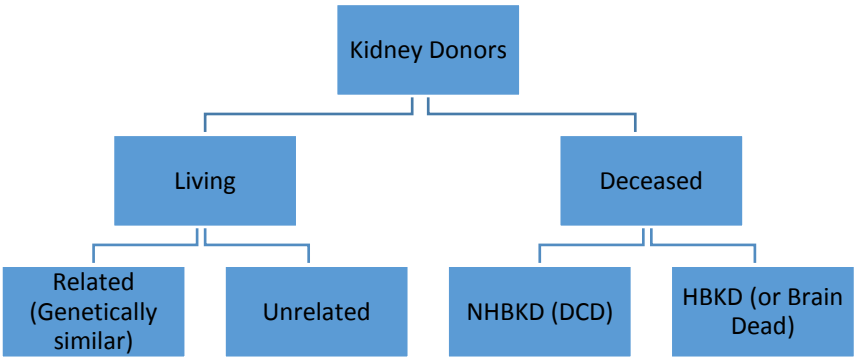

Figure 1: Types of Renal donors.

Based on recent United Network for Organ Sharing (UNOS) data, living donors currently make up almost a third of the donations[1]. All potential donors need to be screened on medical and psychological grounds to guarantee fitness for surgery and ascertain if there are no underlying conditions which would lead to unnecessary poor outcome, for either the donor or the recipient.

Daar et al proposed an ethical classification for living donor renal transplantation. Five categories were described:

1. Living-related donation;
2. Emotionally related donation;
3. Altruistic donation;
4. "Rewarded" gifting; and
5. Rampant commercialism.

Ethical issues for categories 1, 2, and 3 are either esoteric or have been resolved. The authors proposed category 4 needs further discussion and elucidation and should be the area of concentration, while category 5 is perceived to be unethical (Daar, Salahudeen, Pingle, & Woods, 1990).

The Human Tissue Act (HTA) 2004 stated that the donors must verify a relationship (long term or familial) or stable friendship with documentation (e.g. photographs, birth/wedding certificates). Only since the turn of the twenty first century has absolutely philanthropic or altruistic donation to a stranger been accepted by the Human Tissue Authority in the UK (Gov, 2004). There must be no financial gain between the donor-recipient pair.

Expanding the donor pool:

With kidney exchange programs there are two ways to increase the donor pool by allowing those who are unable to receive a kidney from a loved one or friend the opportunity to still receive a kidney through an exchange between incompatible donor-recipient pairs:

1. Kidney swap: if donor and recipient have a different blood type, they can exchange their kidneys with another donor and recipient pair in a similar situation.

[1] Based on UNOS (United Network for Organ Sharing) database (January 1, 2011 - December 31, 2015); OPTN data July 29, 2016

2. Kidney chain: an altruistic donor kidney is transplanted into a recipient who had a donor willing to give a kidney, but was not a match. To keep the chain going, the incompatible donor gives a kidney to a patient unknown to him or her who has been identified as a match, essentially "paying it forward" (UCLA, 2015).

Many of the advances in transplantation have developed due to the increasing demand on the donor pool, with large numbers of patients on the waiting list. For example, it is now possible to transplant across a positive cross match in high risk patients with a substantial number of preformed antibodies to potential donors. The antibodies are formed following exposure to foreign antigens, such as in pregnancy, previous transplants, or blood transfusions. Many centres, such as the Saint Luc Hospital, Brussels, have protocols to allow the sensitized recipients to receive kidneys from donors against whom they may have a positive reaction. These programmes commonly include pre-transplant plasmapheresis sessions to rid the recipient of the antibodies, and intravenous immunoglobulin (IVIG) to prevent their return. Most of the recipients either require splenectomy and/or immunosuppression or rituximab without a splenectomy after the transplantation (Squifflet, 2004). The donation only occurs once the cross match becomes negative. Postoperatively additional plasmapheresis and immunoglobulin infusions may be necessary.

With an increased demand for organs, an expansion of the donor pool has occurred. The boost in living donors has had the greatest effect on the waiting list, but increased use of DCD kidneys and Expanded Criteria Donors (ECD) can improve organ availability. ECD kidneys are from donors who either >60 years of age or are >50 years old and who have any two of the following list: diabetes mellitus, hypotensive donors, hypertension, cerebrovascular injury as cause of death, donors with history of malignancy, or global renal dysfunction (Ramer, 1996). Routinely these kidneys have higher risk of delayed or non-function. If patients are willing to accept the associated risks of this transplantation, the expanded criteria donor kidneys are distributed to these patients.

Living donor nephrectomy:

Traditionally the living donor nephrectomy is under a general anaesthetic, with the patient in the supine position. The skin incision is either in the flank (with or without rib resection) or anterior (extraperitoneal or intraperitoneal) position. Laparoscopic Donor Nephrectomy

(LDN) has become the preferred technique at most centres in the United States (Wein, 2012) as there may be less pain and a faster recovery, along with reduced operation time and complications. LDN has led to an increase in the number of living donors (Schweitzer, 2000). The first robotic donor nephrectomy was performed at Saint Barnabas Medical Centre in Livingstone, NJ, USA in 2009, through a small 5cm incision (News, 2009). Also in the USA in 2009, at Johns Hopkins Medical Centre in Baltimore, MD a healthy kidney was recovered via a donor's vagina. This procedure is referred to as NOTES (Natural Orifice Transluminal Endoscopic Surgery) and was possible because the patient had a prior hysterectomy (CNN, 2009). Single port laparoscopy, through the umbilicus (Rané, 2008), and laparoscopic assisted nephrectomy (Ratner, 1997) have also been performed. All the laparoscopic techniques are associated with a number of challenges, such as the pneumoperitoneum, which may impede the venous return and further hamper graft function post operatively.

Consent for nephrectomy:

Living donors will give permission for a nephrectomy with informed consent being obtained prior to the procedure. With deceased donations such as in South Africa we have an opt-in system where relatives/next of kin/guardians are asked for consent to procure organs. The population is given the option of a living will and may be part of an organ donor society.

Some countries follow the presumed consent and will accept that all patients are donors, unless stated differently (the opt-out system), but most countries will follow the former condition. According to the Spanish Transplantation Law there is an opting-out system for consent to donation in Spain has been in place since 1979 although it is not always strictly adhered to, and relatives are always approached and still have the final say (Matesanz, 2011).

Deceased donor nephrectomy:

Deceased donations can be classified as either brain dead/heart beating kidney donors (HBKD) or donation after cardiac death/non heart beating kidney donors (NHBKD). HBKD are Diagnosed as brain dead according to specific neurologic criteria, yet the heart continues to pump and maintain the perfusion of the organs while being procured (Weber,

Dindo, Demartines, & et al, 2002). Ideal donor criteria would include no hypertension or diabetes, normal renal function, no malignancy (except for intracranial and superficial skin lesions which have been treated), no generalised bacterial or viral infections, aged between 6-50years, acceptable urinalysis, and negative testing for hepatitis, HIV, syphilis, and human T lymphoproliferative virus (Wein, 2012).

Donation after cardiac death/non heart beating kidney donors (DCD/NHBKD) include patients who have a limited chance of recovery, and do not fulfil the criteria for brain death. Once the donor has been declared dead, a multi organ harvest is performed after the patient has been transferred to an operative theatre. The donors are perfused with preservation solutions and anticoagulation (e.g. heparin) (Watson, 2012). With these donors there are a number of ethical and practical rules to comply with, most importantly, the recovery team may not participate in patients' care prior to being declared dead. Most deceased donor kidneys come from HBKD, but increasingly the DCD are being used as a source of allografts, particularly in organised manner of support withdrawal in an operative theatre, with procurement team ready for organ retrieval. The outcome of these donor kidneys are similar to those obtained from HBKD, if the kidneys are perfused with a pulsatile perfusion of preservation solution (Weber, Dindo, Demartines, & et al, 2002).

The procurement procedure differs between living and deceased donors. The living donor operation is an elective or scheduled procedure which allows optimal preparation for both donor and recipient, and ensures compatibility and adequate work up of the donor. There is minimization of organ preservation time and total ischaemic time. Total ischaemic time is the time from removal of the kidney to the reinstatement of blood flow in the recipient, and should be less than an hour. The shorter preservation and cold ischaemic time may have very low degrees of initial poor graft function in the recipient (Weber, Dindo, Demartines, & et al, 2002). The majority of the kidneys produce adequate volumes of urine within a short period and adequate clearance of creatinine with in the first postoperative day. According to the literature the left kidney is preferred because of the implantation benefits associated with a longer left renal vein (Wein, 2012). However, some prefer the right kidney for reasons of anatomical preference. At the end of the procedure the skin incision is closed in layers and the patient recovered.

Deceased donor procurement is a more rapid, complex multi-organ operation compared to living donations, with a thoraco-abdominal incision used. The kidneys are generally recovered along with liver, pancreas, heart, lungs, cornea, skin and occasionally intestines. Organs are perfused with the heart beating or via perfusion pumps with a cold (i.e. 4^0C) preservation solution. The latter has a high concentration of potassium to depolarize the cell membrane, thereby decreasing metabolic demands associated with maintaining gradients of sodium and potassium. Various solutions contain multiple constituents, such as impermeable solutes (e.g. lactobionate, raffinose, and hydroxyethyl starch) or sugars, to prevent cellular swelling; albumin/dextran, to maintain osmolality and prevent extracellular fluid compartment expansion; phosphate (for hydrogen ion buffering); free radical scavengers and other substances (e.g. allopurinol) to minimize reperfusion injury; membranes are stabilised (magnesium and dexamethasone); adenosine is used for ATP synthesis during reperfusion (Wein, 2012). The kidneys are removed with their vasculature (including a cuff of Aorta and/or IVC) and ureter. The organs are then stored in preservation solution and preserved at 4^0C during transport for the recipient procedure.

Recipient operation:

The actual transplant recipient procedure is under a general anaesthetic, with prophylactic intravenous antibiotics and insertion of a 3-way urinary catheter. The skin incision is usually an oblique lower abdominal quadrant cut (known as the Gibson incision), on either side. The side for recipient transplantation varies in the surgical text. Some reference texts use either side but state that right sided vasculature is more preferable for anastomosis (Smith's Urology 2004). Glen's Urological Surgery (2004) always uses the contralateral side, and some of the newer texts agree with this (i.e. the right donor kidney to the left recipient pelvis) (Wein, 2012).

The vascular anastomoses are typically fashioned with vascular sutures such as Prolene®, in either an interrupted or continuous method. The donor renal artery can be anastomosed to either of the following: external/internal/common iliac artery. The anastomosis is typically an end-to-side anastomosis of renal artery to external iliac artery. However other approaches have been used, including end-to-end anastomosis with internal iliac artery (Matheus, 2009), some patch techniques, or use of vascular auto- or allografts. The donor

renal vein is anastomosed to either of the following veins: external/internal/common iliac vein, or even the inferior vena cava. However, as with the artery, variations are described, such as end-to-end or end-to-side anastomoses.

The ureteric anastomosis has two options described. The first is the ureteroneocystostomy, where the ureter is attached to the recipient bladder either through a submucosal tunnel (Leadbetter-Politano procedure), or the tip may be anastomosed directly to bladder mucosa and partially covered by the mucosa (Lich-Gregoir procedure). The second option is the ureteroureterostomy, which is used in rare situations where it is not possible to join the ureter straight to the bladder – in such cases where the ureter was devascularised and dissected too short during the harvesting procedure. Most surgeons perform an antireflux procedure, and some prefer extravesical to transvesical approaches - as it is faster, a separate cystostomy is not required, and less ureteral length is needed, ensuring adequate blood supply (Wein, 2012).

The use of a ureteric stent to facilitate the anastomosis and lessen the risk of obstruction is very individualized. If a stent is used, it is imperative to arrange cystoscopic stent removal after a few weeks (Wein, 2012) or the use of newer magnetic stents, because forgotten stents can cause haematuria and serve as nidus for infection, stone formation and obstruction. Some units use a “stent on a string” or attach it to the urinary catheter and remove it without cystoscopy (Sansalone, 2005).

The wound is generally closed in layers to approximate the musculature and soft tissue. Many centres leave drains in the new renal bed, while others avoid this technique. It is easier to remove a drain than to regret not placing it intraoperatively (Wein, 2012).

Immunosuppression is initiated at the completion of the procedure. Intravenous fluids for maintenance (0.45% saline with 5% dextrose) and to match urine output (0.45% saline) are provided. As the function improves, the fluid balance must be maintained with careful monitoring of the patient's input and output, while replacing the losses. Sometimes electrolyte abnormalities must be corrected. The anti-hypertensive medication may need to be adjusted or stopped. Most patients are on low dose anticoagulation to prevent deep vein thrombosis for a period after the procedure (Wein, 2012).

Immunosuppression:

A comprehensive discussion on immunosuppression is beyond the scope of this study. There are two phases: induction and maintenance. For some patients, induction is started prior to transplant, continued during and then following the procedure. The immunosuppression is divided into antibody and non-antibody regimes. Typical antibody based induction uses either a monoclonal or polyclonal antibody preparation directed at T lymphocytes, in combination with a calcineurin inhibitor [CNI] (e.g. Cyclosporin, Tacrolimus), an antiproliferative agent (e.g. Azathioprine, Mycophenolate), and corticosteroids. Maintenance includes different combinations of above, but excluding the antibody preparations (McGill & Ko, 2011).

Induction options vary between centres. The units that do not use antibody induction, mostly agree that they should be used in high risk patients, such as redo transplant patients, especially when the first kidney was lost to rejection, and recipients with evidence of sensitization, noted by a high PRA titre.

Complications after transplantation:

Transplant complications are varied. Transplantation complications may be divided into renal-related and extra-renal (Kobrzycki, 1977) (see figure 2).

Renal	**Extra-renal** (immunosuppressive/drug related)
Rejection (hyper-acute, acute, & chronic)	*Infections, including TB*
Technical failures	*GIT bleeding*
Acute tubular necrosis (ATN)	*Hepatitis*
Recurrent nephritis	*Pancreatitis*
	Psychological

Figure 2: Complications after transplantation.

Delayed graft function - defined by requirement for dialysis within 7 days post operatively - varies depending on donor, recipient and transplant characteristics. It is less common with living donor kidneys, probably because of the short cold ischaemic time (CIT). The CIT is also

the best predictor of delayed graft function in the deceased donors. Most kidneys with delayed graft function eventually work, but they do have a shorter long term survival compared with those that function immediately (Shoskes D. , 1996).

Early dysfunction can be due to infection, allograft rejection, urinary or vascular obstruction, drug toxicity (calcineurin inhibitor nephrotoxicity), hyperglycaemia, or dehydration (Wein, 2012). This is associated with longer hospitalisation and therefore greater perioperative expense. Donor factors and prerenal, renal, or postrenal transplant factors related to the recipient can contribute to the dysfunction. Experimental studies show that both ischaemia and reinstitution of blood flow in ischaemically damaged kidneys after hypothermic preservation activate a complex sequence of events which cause renal injury and play a pivotal part in the development of delayed graft function (Perico, 2004).

Vascular complications are uncommon but an important cause of dysfunction and graft loss (Zilinska, 2010). It may be immediate with kinking of the artery or vein, suture line stenosis, or thrombosis. Thrombosis may be due to hyper-acute rejection or thrombophilia (Wein, 2012). Renal artery thrombosis occurs more commonly with small calibre arteries, but is quite infrequent. A nephrectomy will be needed if thrombectomy is unsuccessful. Arterial stenosis can occur after months or even years, and generally has an abrupt onset of hypertension which is progressively difficult to manage, with or without impairment of renal function. It can be caused by technical failure (sutures), clamp trauma, atheromatous plaques, or immunological mechanisms (Wein, 2012). Although ultrasound with Dopplers can help, angiography is usually needed to confirm and exclude proximal vascular disease. Percutaneous transluminal angioplasty with or without stenting may be used as surgery may be challenging (Wein, 2012). Venous thrombosis also occurs. Rarely thrombosis of the main vein can be treated with thrombolytic agents, but usually graft infarction has occurred by time of diagnosis, and this generally requires nephrectomy of the transplanted kidney.

Ureteral obstruction is the most common urinary tract complication after infection, and can be early or late. Early obstruction may be from a clot, oedema, or technical faults. If a urinary catheter placement and expectant management does not resolve the problem, revision may be needed. Late obstruction, if not from an external compression (e.g. pregnancy or lymphocele) is mainly caused by fibrosis or nephrolithiasis. These can be

managed radiologically or endoscopically, with ureteral stenting, stricture dilation and ureterorenoscopy (URS) as options (Shoskes, Hanbury, & Cranston, 1995).

Fluid collections are usually discovered incidentally using ultrasound and do not require treatment. If large or associated with pain, fever, hydronephrosis, or unexplained decline in renal function, a percutaneous aspiration (ultrasound guided) can be performed. If there is a significant recurrence or increase, then most need to be explored or repaired (Wein, 2012).

Urinary leaks can take place from any site from the renal pelvis to the bladder, and should be suspected when a recipient with good or improving graft function suddenly develops a fluid leak from the wound, or abdominal pain, or perineal swelling, typically within a month of transplant. Fluid should be tested for creatinine - urine has higher level than the serum, and lymph usually has a similar level to the serum. A computed tomography (CT) cystogram or intravenous pyelogram (IVP) or retrograde pyelogram (RPG) may show the urinary leak. A renogram is also useful. Small leaks can be managed with a catheter decompression, ureteric stents or percutaneous nephrostomy. Larger and more proximal leaks typically need exploration and repair (Shoskes, Hanbury, & Cranston, 1995).

Lymphatic leaks from the perivascular tissue can cause a lymphocele which collects between the donor kidney lower pole and the recipient bladder. This can present as a pain, swelling over the transplant, and deranged renal function within the first post-operative year. Treatment options include percutaneous drainage, percutaneous aspiration with instillation of a sclerosing agent or internal surgical drainage by open or laparoscopic surgery (Chin, 2003). Percutaneous aspiration occasionally solves this complication, but prolonged catheter drainage can have a high risk of infection. Sclerotherapy with 5-10% povidine iodine, may be successful in small, unloculated collections (Zomorrodi, 2007). Fibrin glue has also been used for this complication (Chin, 2003). However the standard management is to create an internal drainage into the peritoneal cavity.

Hyper-acute rejection is mediated by preformed cytotoxic antibodies (pregnancy, blood transfusion, or prior failed transplant), and is an irreversible process occurring directly after revascularisation (Wein, 2012). Acute rejection can occur after the procedure, but it has become less of a problem with better immunosuppression. Acute rejection is more common than hyper-acute and chronic rejection, occurring from fifth postoperative day and usually

within the first three months, but may occur later (Kälble, et al., 2005). Patients are usually asymptomatic, although some have “flu like symptoms” along with pain over an enlarged graft, hypertension, decreased urine output, and an increased serum creatinine. The renogram may show decreased blood flow, glomerular filtration and tubular function. The biopsy usually shows mononuclear cell infiltration with vasculitis and tubulitis (Wein, 2012). Most episodes are managed with a short course of steroids. Failure to respond may require urgent change of therapy (e.g. antilymphocyte antibody agents). Rejection does not always lead to failure of the transplant, but may require more treatment to suppress the process. Chronic rejection appears to have both immunological and non-immunological parts. It is characterised by a gradual decline in renal function associated with minimal mononuclear cell infiltration, vascular changes and interstitial fibrosis on biopsy (Wein, 2012). Unfortunately it is not treatable, and risks include poor initial graft function and a history of acute rejection episodes.

Post-transplant lymphoproliferative disorders are noted as a complication from immunosuppression (such as a form of lymphoma). Recipients are more likely to develop cancer than the general population or patients on the transplant waiting list, and types of cancers include Kaposi sarcoma, non-Hodgkins lymphoma, non-melanomatous skin cancers, and kidney cancers (Wein, 2012).

Chapter 2:

Introduction:

Renal transplantation has become established as the treatment of choice for most patients with chronic end stage renal failure and is performed routinely in most major centres throughout the world. The outcomes after transplantation are very good with over 90% of patients surviving long term.

Historically the technical aspects of renal transplantation were developed and refined in the early 1900s. The first successful human renal transplants were performed in 1954 by Joseph Murray when they were able to overcome the immunological barriers by performing a living donor transplant between two identical twin brothers. However large scale successes after renal transplantation were only achieved after the introduction of various immunosuppressive drugs in the 1970s and 1990s.

The surgical procedure is now well established and involves anastomosing the donor kidney renal artery and vein to the recipient external iliac artery and vein, and the donor kidney ureter to the recipient bladder. Most reports on the outcomes after renal transplantation in the literature indicate that the standard transplant procedure was used to implant the donor kidney into the recipient. However, there are many variables in the technical aspects of the transplant procedure which may depend on the transplant centre and the individual surgeon.

Aim:

This survey was designed to assess the global standards in renal transplant surgery and to see what is the actual standard transplantation described.

The primary outcome of the survey was to compare and discuss the trends in local and international responses. The secondary outcome of this thesis was to prepare a summary of the history of renal transplantation, with specific reference to the surgical management thereof.

Ethics:

As the questions related to the surgeons and their professional experiences and preferences, no patient information was requested or provided. Surgeons were given the option to provide their names and contact details, but this was not necessary for the purpose of the survey. Any personal information which was captured was stored on a secure server. The survey was an anonymous questionnaire. The raw data was viewed by principal investigator and a statistician from the Department of Statistics, UCT, and upon request by the co-author. Ethics approval was obtained from the Human Research and Ethics Committee of the Faculty of Health Sciences at the University of Cape Town. The reference number is (HREC REF) 193/2015.

Method:

A pool of surgeons involved in renal transplantation, both in South Africa and internationally was identified and these 147 medical professionals were contacted via email to complete the survey. If the initial email was not answered, a second email was sent to the address provided. The participation in the survey was voluntary. The questionnaire was created using the Qualtrics® online survey software and was designed to obtain data in three main areas of interest, namely background information of the surgeon, the transplant procedure, and the post-transplant events (see appendix 1).

The specific questions were as follows:

A. Background Information:
    1. What is your speciality?
    2. Do you work in public or private sector?
    3. How long have you been performing transplants?
    4. How many renal transplants does your unit perform per year?
    5. Approximately what percentage of transplants performed, are from living donors?
B. Transplant Procedure:
    1. Donor Nephrectomy:

i. In a cadaver (non-living) donor, do you perfuse the kidney in situ or ex situ only?
ii. In an open (non-laparoscopic) living donor nephrectomy, which kidney do you prefer to harvest (if there are no anatomical abnormalities)?

2. Recipient:
    i. In the recipient, which side do you prefer for the first transplant?
    ii. During the transplant procedure, in the recipient, do you:
        a. Ligate and divide the inferior epigastric vessels?
        b. In males, ligate and divide the spermatic cord?
        c. In females, ligate and divide the round ligament?
    iii. In living donor transplants, which recipient artery do you use for the renal artery anastomosis?
    iv. Which recipient vein do you use for the venous anastomosis?
    v. What technique do you use for the ureteric anastomosis?
    vi. Do you use a stent for the ureteric anastomosis?
    vii. What suture material do you use for the:
        a. Arterial anastomosis?
        b. Venous anastomosis?
        c. Ureteric anastomosis?
    viii. In what order do you unclamp the vessels?

C. Post Transplantation:
    1. Do you use a suction (Portovac®) drain postoperatively?
    2. When do you remove the urinary/bladder catheter?
    3. Do you routinely perform post-transplant biopsies?
    4. In suspected acute rejection, do you perform a biopsy or do you treat empirically?

The raw data was collated using Qualtrics® and these results were analysed by the Department of Statistical Sciences at the University of Cape Town.

Results:

Of the 147 surgeons emailed, 43 started the survey, but only 30 actually completed the survey, giving a response rate of 20.4%. The survey took on average 7 minutes to complete.

The questions which requested the respondent's name and institution were optional. These fields were not required to complete the survey. Three respondents (10%) chose to remain completely anonymous, and two respondents supplied their names, but chose not to disclose their institution (2%). The responses (see figure 3) were South Africa (n=8), Europe (n=8), India (n=4), United States (n=4), Australia (n=3) and Guatemala (n=1). There were 8 responses from South Africa (27%) and 20 responses from the rest of the world (67%).

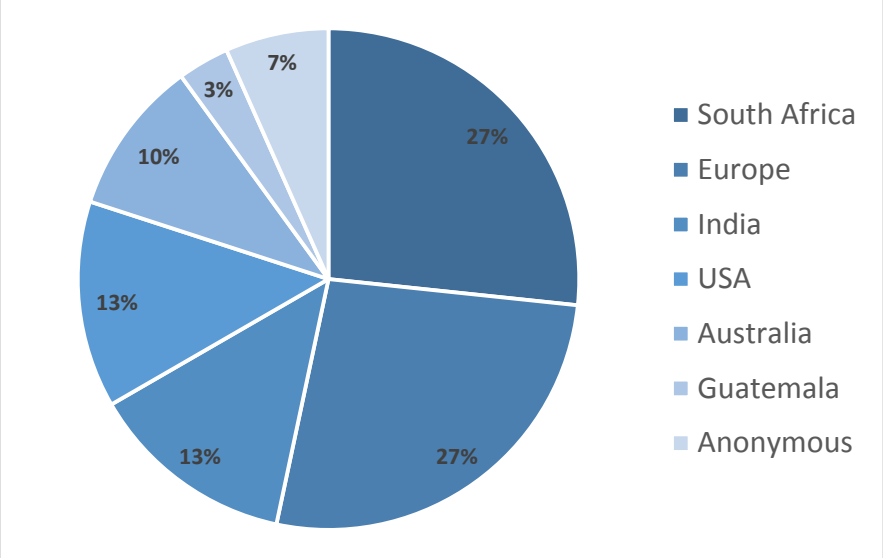

Figure 3: Country of practice.

Surgeons were asked to specify their speciality and this is shown in figure 4. The majority of the respondents (84%) considered themselves to be transplant surgeons. There were three urologists and one general surgeon.

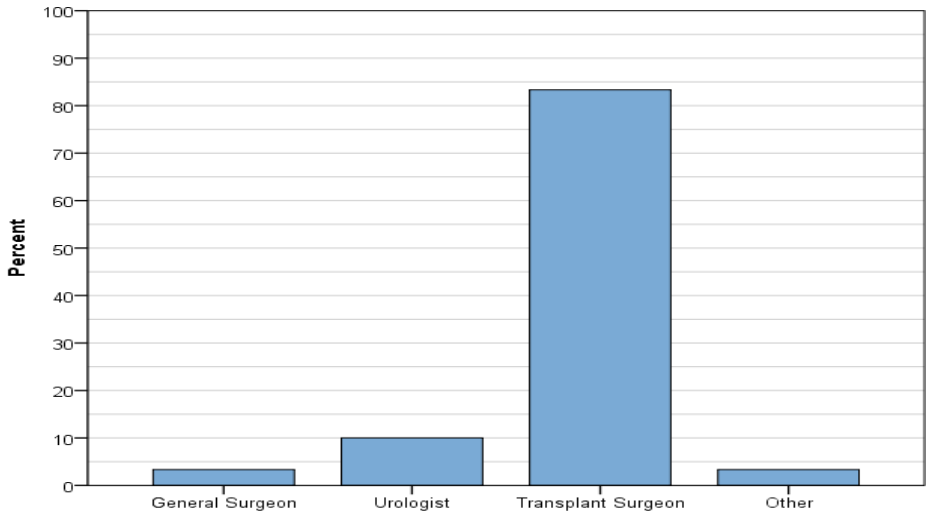

Figure 4: Surgical speciality.

The experience of the respondents is shown in figure 5. Almost two-thirds (63.3%) of the respondents had been involved in transplantation for over 10 years.

Years of Experience	Percent
<5 years	20
5-10 years	16.7
10-15 years	16.7
15-20 years	3.3
>20 years	43.3

Figure 5: Number of years of experience performing transplants.

Two-thirds of the surgeons worked exclusively in the public sector (n=20) and 10% (n=3) only in the private sector. The remaining 23.3% (7/30) stated shared responsibilities in both the public and private sector.

Three surgeons worked in units which performed less than 20 transplants per year. There were two units which performed 21-40 and five which performed 41-60 transplants per year. Two, six and twelve units performed 61-80, 81-100 and more than a 100 transplants per year, respectively. Stated differently, two-thirds (n=20) of participants estimate that their units perform more than 60 transplants a year.

The majority of the respondents (n=21) stated that less than 50% of the transplants were living donations (see figure 6).

Percentage of Living Donors:	Respondents:	Percentage (%):
<10%	1	3.3
11-20%	2	6.7
21-30%	4	13.3
31-40%	11	36.7
41-50%	3	10
>50%	9	30

Figure 6: Percentage of Living donors.

The respondents were asked how the kidneys were perfused in cadaver (non-living) donor nephrectomies. Eleven surgeons used only *in situ* perfusion and three surgeons used *ex situ* perfusion exclusively. The majority (53.3%) used a combination of *in situ* and *ex situ* perfusion.

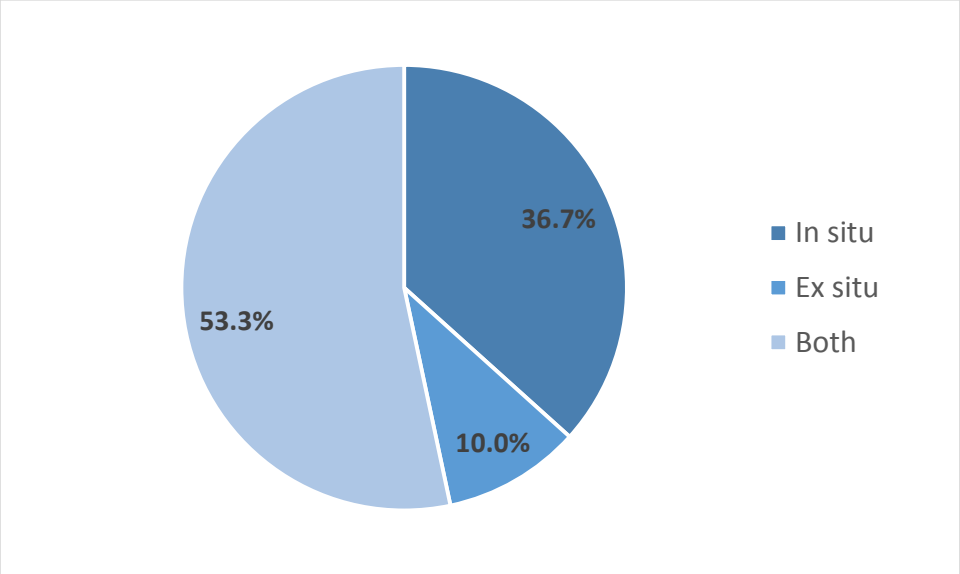

Figure 7 Type of perfusion in cadaver nephrectomy.

The respondents were asked which kidney they would remove in preference during an open (non-laparoscopic) living donor nephrectomy in the absence of any anatomical

abnormalities (Figure 8). Sixty three percent preferred the right kidney, twenty percent preferred the left kidney and seventeen percent had no preference.

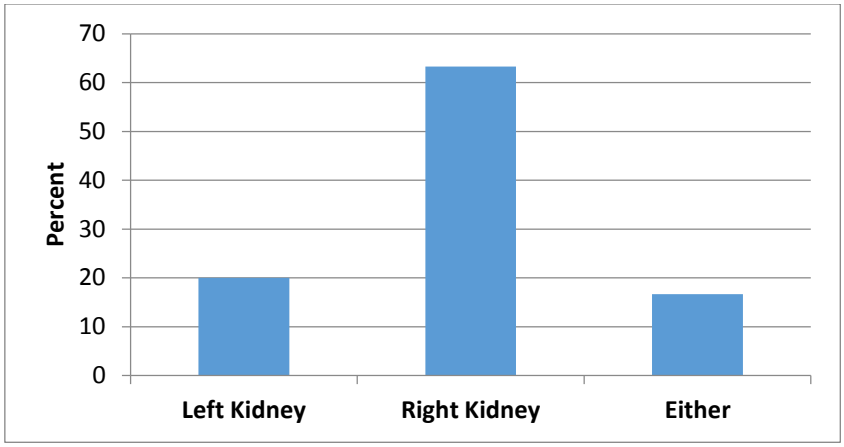

Figure 8 Side preference in an open (non-laparoscopic) living donor nephrectomy with no anatomic abnormalities.

With regard to the transplant in the recipient, the vast majority chose the right side (76.7%), and the remainder opted for the left or right side depending on whether it was a right/left donor kidney (23.3%). None of the respondents chose the left side preferentially.

There were considerably more respondents who routinely ligated the inferior epigastric vessels (80%) compared to those who occasionally (16.7%) and never (3.3%) ligated these vessels (figure 9).

Substantially more surgeons never ligated and divided the spermatic cord in males (90%) compared to those who occasionally (6.7%) and routinely (3.3%) ligated and divided the spermatic cord (figure 9).

In contrast, more surgeons routinely ligated and divided the round ligament in females (76.7%) compared to those who occasionally (16.7%) and never (13.3%) ligated and divided (figure 9).

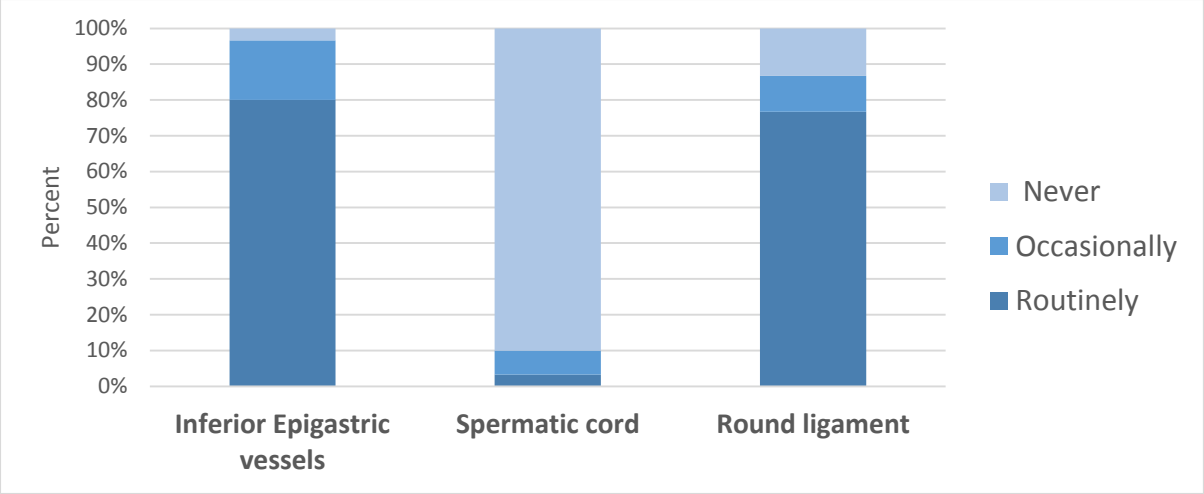

Figure 9: Preference of the surgeon for ligating or dividing three key anatomical structures in the recipient.

There was no difference in the vessel of preference for the renal artery anastomosis in living donor transplants. Fourteen respondents performed an end-to-end anastomosis with the internal iliac artery and the remaining sixteen used the external iliac artery in an end-to-side anastomosis. The majority of surgeons anastomosed the renal vein to the external iliac vein, compared to the common iliac vein (86.7% versus 10%). Only 3% used the inferior vena cava or other vein and nobody used the internal iliac vein.

When performing the ureteroneocystostomy (ureteric anastomosis to the bladder), most surgeons (80%) used a mucosa-to-mucosa anastomosis with a tunnel. Ten percent of surgeons did not use a tunnel (see figure 10).

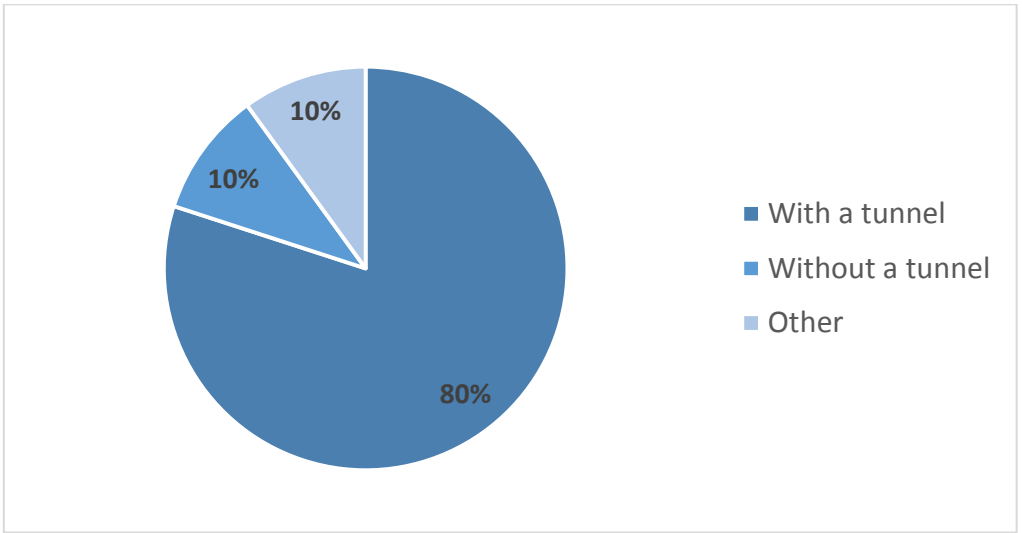

Figure 10: Type of ureter to bladder anastomosis.

With regard to the use of a DJ stent for the ureteric anastomosis, 18 (60%) of respondents indicated that they used it routinely, one used it occasionally, seven used it very occasionally, and four respondents never used a stent (see figure 11).

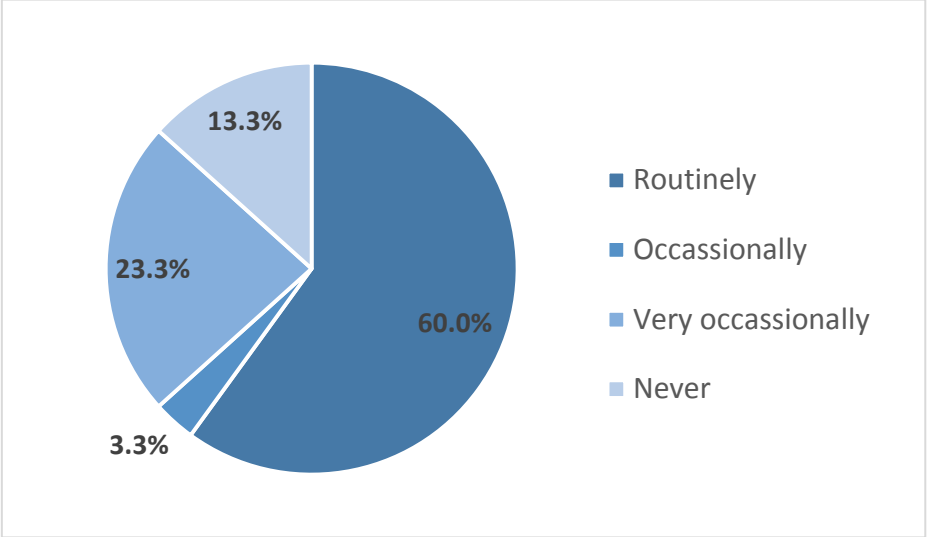

Figure 11: Use of DJ stent for ureteric anastomosis.

As expected the surgeons used Prolene 5/0 or 6/0 for the vascular anastomoses. Respondents used Maxon or PDS (5/0 or 6/0) for the ureteric anastomosis with considerably more surgeons using PDS (16 versus 7).

When asked about the order of unclamping the vessels after the renal transplant, a third of respondents would unclamp the artery first, 56.7% (n=17) would unclamp the vein first, and 10 % (n=3) unclamp both simultaneously (figure 12).

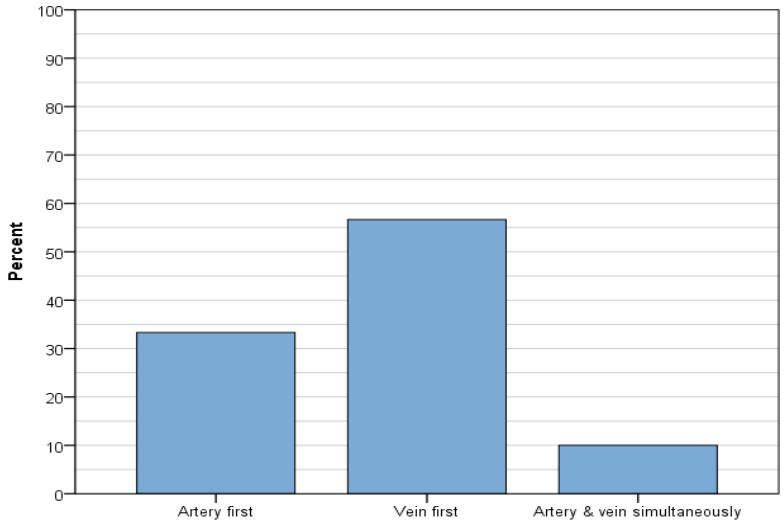

Figure 12: Order of vessel unclamping post transplantation.

Sixty percent of the respondents routinely used a closed suction drain after the transplant and a third never used a drain. Two surgeons occasionally used a drain.

The timing of the removal of the bladder catheter was quite variable. Thirty percent removed the catheter early (between one and three days post operatively), whereas 66.6% removed the catheter between four and seven days. One respondent indicated they removed the catheter after seven days.

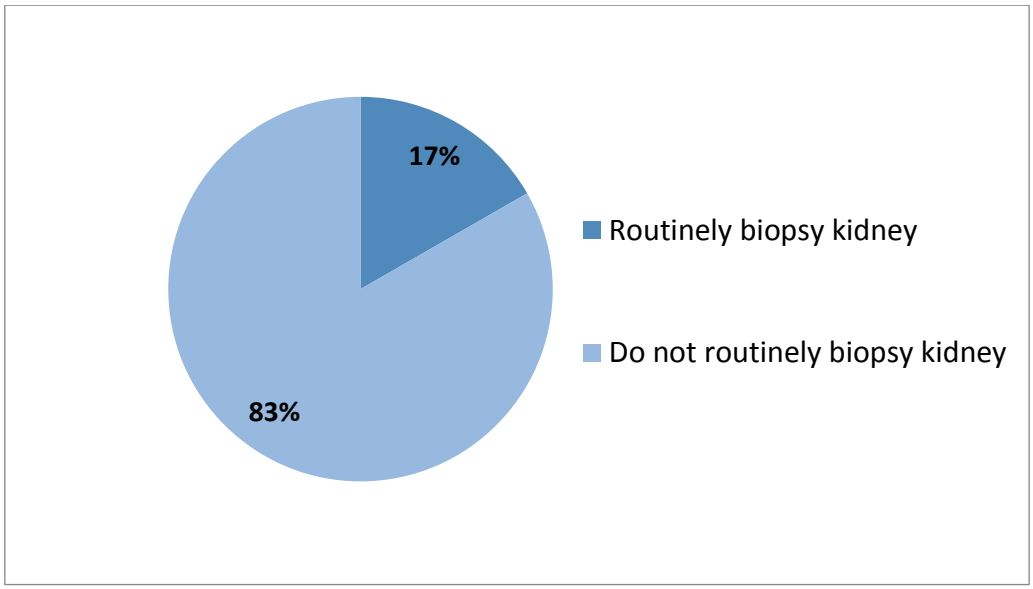

Figure 13: Choice of surgeons to routinely biopsy post- transplant.

As shown in figure 13, the vast majority of the respondents (83.3%) do not routinely perform a post-transplant biopsy. However, if acute rejection was suspected, substantially more respondents would perform a biopsy before commencing anti-rejection therapy, compared to those who would treat empirically without a biopsy (63.3% versus 13.3%).

Discussion:

The technical aspects of renal transplantation were developed in the early 1900s and have now become relatively standardized. The donor kidney is implanted into the recipient iliac fossa, usually on the right side, with the renal artery and the renal vein anastomosed to the external iliac artery and vein respectively, and the ureter to the bladder. Although renal transplants are performed on a routine basis in most major centres throughout the world, it remains unclear just how standardized the operation is. In this study we undertook an online survey of surgeons in different parts of the world to determine the level of standardization of the renal transplant procedure.

The vast majority of respondents were transplant surgeons with substantial experience in transplantation as 63.3% of surgeons declared they had been performing transplants for more than ten years, and 66.6% worked in large volume transplant units that performed 60 or more transplants per year, which is more than one transplant per week. Since respondents were asked to classify their speciality themselves and no proof was requested, some of these surgeons may have had their training as general surgeons, yet consider themselves to be transplant surgeons after many years of experience.

Donor kidneys can be sourced from living or deceased donors as discussed in detail in Chapter 1. The literature review has shown that one of the major challenges facing kidney transplantation today is the critical shortage of deceased donors, and as a consequence there has been a move to increase the donor pool and therefore some centres are trying to increase their use of living donors. The results of this study show only 30% of respondents indicated that they use more than 50% living donors. In general, living donors are used out of necessity rather than choice as this has an impact on the living donor who undergoes an unnecessary surgery and is exposed the associated possible risks.

When performing a donor nephrectomy in a deceased donor, the perfusion of the kidneys with ice cold preservation fluid can be done either *in situ*, *ex situ* or a combination of both. The ice cold preservation solution as discussed in the literature review is to maintain the cold ischemia time and lessen the complications post operatively, compared to warm ischemia time. Approximately half of the surgeons in this study used a combination of both *in situ* and *ex situ* flushing of the kidneys, and about one third only flushed *in situ* without

further flushing after the operation. Work by St Peter et al in the Lancet showed that continuous perfusion could provide a supply of metabolic substrates and removes waste, partially recreating the normal circulation. While cold flush preservation, is simpler and cheaper, which is why it has become the standard means of organ preservation. The cold storage of marginal organs comprises four consecutive injuries: preretrieval injury, cold storage ischaemia, ischaemic rewarming (warm ischaemia), and reperfusion. Continuous perfusion could stop this and replenish or maintain substrates during preservation of organs. This perfusion can be done before storage or before reimplantation (St Peter & Friend, 2002).

Deciding which kidney to remove from the living donor in the absence of any anatomical anomalies appears to be a matter of personal preference. Traditionally, the left kidney is preferred because of the longer left renal vein. However, anatomical anomalies of the venous drainage of the kidney are more likely to occur on the left side. These include the circumaortic, retroaortic veins, and the nutcracker phenomenon (with trapping of the left renal vein between the aorta and superior mesenteric artery) all being more commonly found on the left side, but multiplicity of the right renal vein is more common than the left renal vein (Matthews, 1999). Although the right renal vein is significantly shorter, retrieval of the right kidney with a cuff of the vena cava attached to the vein results in a length of vein which is the same as in the deceased donor nephrectomy. Not surprisingly, the majority of the respondents preferred to remove the left kidney from the living donor. However it is interesting to note that about one third of the surgeons chose to remove the right kidney in preference.

The transplant in the recipient is usually performed on the right side because of the beneficial anatomy of the external iliac vessels on that side. However, there are still some surgeons who believe in transplanting the kidney on the contralateral side so that the renal pelvis and ureter are anteromedial to the parenchyma, which would improve access to these structures in the event of a post-transplant ureteric complication needing surgical intervention. In this study, about three-fourths of the surgeons said that they would transplant the kidney into the right iliac fossa preferentially and one quarter said that they transplanted the kidney contra-laterally preferentially. There were no surgeons who would use the left iliac fossa preferentially.

There is no doubt that division of the inferior epigastric vessels, and the round ligament in females and the spermatic cord in males would improve access during the transplant procedure. However, as confirmed in this study, most surgeons would try to preserve the spermatic cord in males to minimise any potential impact on fertility. The vast majority of surgeons would divide the inferior epigastric vessels (80%) and the round ligament (76.6%), and would preserve the spermatic cord (90%). The inferior epigastric vessels can be ligated to prevent troublesome bleeding and ischemia of the ipsilateral rectus abdominus musculature should be prevented by an intact blood supply from the superior epigastric vessels.

In deceased donor transplantation the anastomosis of the donor renal artery to the external iliac artery in an end-to-side fashion is facilitated by the presence of the Carrel patch, where a piece of the aorta is procured with the renal artery. In contrast, the living donor kidney does not have a Carrel patch and an end-to-side anastomosis to the external iliac artery with a small calibre renal artery can be challenging. There is a good calibre match between the internal iliac artery and the renal artery and maybe the former should be used in preference. However the dissection of the internal iliac artery can be challenging, which not all surgeons are comfortable with, and therefore prefer using the external iliac artery. In the current study, the number of surgeons using the internal iliac artery and the external iliac artery for the arterial anastomosis in living donor transplantation was similar (46.7% versus 53.3%), indicating that either can be used appropriately.

There was greater conformity with regard to which vein to use for the venous anastomosis, with 86.7% using the external iliac vein as it is more accessible and has a more preferential horizontal lie of the vessel for the anastomosis. In the study only a few surgeons would prefer using a larger vein such as the common iliac vein or inferior vena cava.

Revascularization of the transplant kidney after completion of the anastomosis is an important step in the transplant procedure which could impact on the outcome. The advantage of unclamping the vein first is that being a low pressure system, it is easier to control any bleeding. Unclamping the artery first is arguably better from an ischaemia-reperfusion point of view. However, there is evidence that venous (deoxygenated) blood has better free-radical scavenging properties. In this survey, 56.7% of the respondents said

that they unclamped the vein first compared to one third who unclamped the artery first. Most of the respondents' answers is supported by work published by St Peter and colleagues in the Lancet, as stated in the section on perfusion above, to improve clearance of waste products (St Peter & Friend, 2002).

The ureteric anastomosis to the bladder has been relatively standardized. In this study, 80% of the surgeons used a mucosa-to-mucosa ureteroneocystostomy (anastomosis of ureter to bladder) with a tunnel. The use of stents when performing the ureteric anastomosis is much less standardized. Sixty percent of the respondents routinely used a stent, whereas 13.3% never used a stent. The evidence shows that there are fewer ureteric complications with stents being used. Work by Dominguez and colleagues in a randomized controlled trial concluded that routine stenting is unnecessary, if at low risk, but careful surgical technique with selective stenting yielded similar results (Dominguez, 2000). Sansalone et al in their retrospective review of eighteen years of their own renal transplants, stated that routine use significantly decreased the incidence of early complications, but it did not modify late stenosis incidence. They attached the stent to the urinary catheter and removed it after 10 days, and concluded that stents should be routinely considered to protect the urinary anastomosis in the early postoperative period when the incidence of complications is highest, without the need of cystoscopy for its removal (Sansalone, 2005).

The question about suture material asked for respondents to choose one option for the suture that they preferred for the arterial, venous and ureteric anastomoses. However some surgeons selected more than one option for some of the choices, therefore making the data difficult to interpret, and only allowing commentary on which suture was chosen more frequently.

There appears to be very little consensus with regard to when to remove the bladder catheter post-operatively. There may be concern about a urinary leak if the catheter is removed too early. Urinary tract infections (UTI) from foreign bodies may occur with catheters left *in situ* for a long period allowing adherent microorganisms to flourish in a biofilm (Trautner, 2004). In the current study, two thirds of the surgeons remove the catheter 4-7 days post operatively. Sansalone and colleagues, routinely kept the transurethral catheter (and ureteric catheter) in for 10 days (Sansalone, 2005). Rabkin et al

stated that a prior study of removal of catheter 8.2 days ± 3.8 days (standard deviation) after surgery had a 73.7% incidence of urinary tract infections within the first post-operative month. They routinely removed the bladder catheters within 48 hours and this significantly decreased the risk of UTIs, without an increase in urological complications (Rabkin, 1998). Urinary tract infections did not increase graft loss but did have an increased mortality risk (odds ratio of 3.5) as seen in the retrospective study by Chaung et al on 500 adult transplants at two US centres (Chuaung, Parikh, & Langone, 2005).

Post-transplant, biopsies are generally performed if there is concern about rejection and some centres will routinely biopsy the renal transplant to ensure the unit is working and free of complications, however this may be associated with morbidities like infections and bleeding. In the current study most of the respondents would biopsy only if indicated. If there are any concerns of acute rejection almost two thirds of the surgeons would biopsy first before starting antirejection therapy. The Groote Schuur Hospital transplant unit performs the post-transplant biopsies percutaneously in a sterile manner, however some units may perform their biopsies in general theatre.

Conclusion:

As with the above discussion there are a number of standards that can be seen from the results. There are a number of experienced transplant surgeons, with the majority of the respondents performing more than 60 transplants annually, working mainly in public and have more than 5 years of transplant experience.

Deceased or Cadaveric donors still appear to be the largest source of donor organs, however, with improvements in minimally invasive techniques and minimal long term morbidity associated with living donor nephrectomy, we may see a possible increase in the living donors in the future.

Despite the respondents having varied backgrounds with regard to place of work and institution of study, there already appear to be enough international similarities in the procedure to describe the transplant as standardized. There is scope for more investigation on this topic and with additional input in terms of more participants and more detailed

question concerning technical aspects of the procedure, an international standard kidney transplant can be comprehensively defined.

Appendix 1

Questionnaire:

Please read and answer the following questions thoroughly. Once finished please return the completed questionnaire to email address provided.

1. Name (optional): .....
2. Institution (optional): .....

Background Information:

3. Please state speciality:
   a) General Surgeon ☐
   b) Urologist ☐
   c) Transplant Surgeon ☐
   d) Other ☐
4. Do you work in public or private sector:
   a) Public only ☐
   b) Private only ☐
   c) Public & private ☐
5. How long have you been performing transplants?
   a) <5years ☐
   b) 5-10years ☐
   c) 10-15years ☐
   d) 15-20years ☐
   e) >20years ☐
6. How many renal transplants does your unit perform per year?
   a) 0-20 ☐
   b) 21-40 ☐
   c) 41-60 ☐
   d) 61-80 ☐
   e) 81-100 ☐
   f) >100 ☐
7. Approximately what percentage of transplants performed, are from living donors?
   a) <10% ☐
   b) 11-20% ☐
   c) 21-30% ☐
   d) 31-40% ☐
   e) 41-50% ☐
   f) >50% ☐

Transplant Procedure:

a) Donor Nephrectomy:

8. In a cadaver(non-living) donor, do you perfuse the kidney:
   a) In situ only ☐
   b) Ex situ only ☐
   c) Both ☐
9. When performing an open (non-laparoscopic) living donor nephrectomy, which kidney do you prefer to harvest (if there are no anatomical abnormalities)?
   a) Right ☐
   b) Left ☐
   c) Either ☐

b) Recipient:

10. In the recipient, which side do you prefer for the first transplant?
    a) Right
    b) Left
    c) Depends on whether it is a Right/Left Donor kidney

11. During the transplant procedure, in the recipient, do you:
    a) Ligate and divide the inferior epigastric vessels:
        i. Routinely ☐
        ii. Occasionally ☐
        iii. Never ☐
    b) In males, ligate and divide the spermatic cord:
        i. Routinely ☐
        ii. Occasionally ☐
        iii. Never ☐
    c) In females, ligate and divide the round ligament:
        i. Routinely ☐
        ii. Occasionally ☐
        iii. Never ☐
12. In living donor transplants, do you anastomose the renal artery (in preference):
    a) End-to-end to the internal iliac artery ☐
    b) End-to-side to the external iliac artery ☐
13. Do you anastomose the renal vein to:
    a) Internal iliac vein ☐
    b) External iliac vein ☐
    c) Common iliac vein ☐
    d) Inferior vena cava or other vein ☐
14. What technique do you use for the ureteric anastomosis?
    a) Mucosa-to-mucosa with a tunnel ☐
    b) Mucosa-to-mucosa without a tunnel ☐
    c) Other ☐
15. Do you use a stent for the ureteric anastomosis:
    a) Routinely ☐
    b) Occasionally ☐
    c) Very occasionally ☐
    d) Never ☐
16. What suture material do you use for the:
    a) Arterial anastomosis:
        i. 5/0 Prolene ☐
        ii. 6/0 Prolene ☐
        iii. 5/0 PDS ☐
        iv. 6/0 PDS ☐
        v. Other ☐
    b) Venous anastomosis:
        i. 5/0 Prolene ☐
        ii. 6/0 Prolene ☐
        iii. 5/0 PDS ☐
        iv. 6/0 PDS ☐
        v. Other ☐
    c) Ureteric anastomosis:
        i. 5/0 Maxon ☐
        ii. 6/0 Maxon ☐
        iii. 5/0 PDS ☐
        iv. 6/0 PDS ☐
        v. Other ☐
17. In what order do you unclamp the vessels:
    a) Artery first ☐
    b) Vein first ☐
    c) Artery and vein simultaneously ☐

Post Transplantation:

18. Do you use a suction (portovac®) drain postoperatively:
    a) Routinely ☐
    b) Occasionally ☐
    c) Never ☐

19. When do you remove the urinary/bladder catheter:
    a) 1-3days ☐
    b) 4-7days ☐
    c) > 7 days ☐
20. Do you routinely biopsy the kidney?
    a) Yes ☐
    b) No ☐
21. If you have concerns about acute rejection, do you biopsy the kidney or treat empirically?
    a) Biopsy ☐
    b) Treat ☐
    c) Both ☐

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