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CASE REPORT

Maintaining a viable vascular access for hemodialysis in an elderly person with diabetes: a journey to live, not just to stay alive

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Key Clinical Message

The longevity of a successful vascular access (VA) is enhanced when the care of the patient's VA is the responsibility of everyone involved, including the patient and their family. A family nursing perspective enhances VA care outcomes and increases quality of life and well-being for patients requiring hemodialysis.

Keywords

Diabetes, end-stage kidney disease, family nursing, hemodialysis, quality of life, vascular access.

Introduction

The case presented is of a 70-year-old Australian Caucasian woman with type 2 insulin-dependent diabetes receiving a regular schedule of hemodialysis therapy for end-stage kidney disease (ESKD). We follow the journey of one person's care where the patient's and her family's goal is to connect deeply with each other while maintaining the patient's quality of life (QOL) and well-being. The active engagement of the family in the care and decision-making process detailed in this case is atypical. However, not every client has a proximal family with functional bidirectional relationships, this case illustrates the importance of including the family or an external personal carer in health care.

Elderly patients receiving peritoneal dialysis or hemodialysis as their renal replacement therapy (RRT), frequently remain reliant on this mode of RRT without release from their dialysis schedules through receiving a kidney transplant. This is commonly owing to a lack of donor organs available for kidney transplantation [8]. This patient, however, was ineligible to receive a donor kidney because of the physiological effects of chronic kidney disease (CKD) and additional comorbidities. Unlike this case study, many elderly patients with ESKD accept a conservative or supportive care pathway that does not involve modalities of RRT [13].

Case History

The patient's medical history included gestational diabetes during her second pregnancy at age 36 continuing onto type 2 insulin-dependent diabetes. For the ensuing 30 years, diabetes became the underlying root cause of the patient's CKD. Both diabetes and CKD have resulted in extensive vascular disease leaving the patient's health-care team, including the nephrologist and vascular surgeons, with the dilemma for establishing the most likely options for a viable VA in readiness for when the patient reached ESKD. Pathophysiology considerations included

the patient's arterial vascular disease which includes calcification being exacerbated by the advancement of the patient's CKD [2, 11].

In early 2010, having reached stage 4 CKD, the patient received an extensive color duplex ultrasonography mapping of her peripheral vascular real estate to assist her nephrologist and vascular surgeon in determining the most appropriate options for her VA. Color duplex ultrasonography is regularly used for this purpose being noninvasive as well as a reasonably accurate method for identifying complications such as functional focal stenotic lesions within the patient's fistula circuit [5]. Elderly people with diabetes leading to ESKD as is experienced by our 70-year-old female patient, frequently suffer a higher prevalence of comorbidity and disability [16], suggest that while the timing and progression of CKD are important factors, additional considerations regarding timing and creation of a patient's VA necessitates the inclusion of the biology of the patient's vascular beds in the patient's assessment.

During these final stages of the patient's CKD, it was determined through discussions between the patient, her family, nephrologist, and vascular surgeon to abandon any attempt of an arteriovenous (AV) fistula conduit for hemodialysis. Together with the patient and her family, that is, husband, daughter, and three sisters educated consensus, it was decided to insert an abdominal catheter for peritoneal dialysis by utilizing the patient's peritoneal cavity to work as a semipermeable membrane for dialysis. This option of RRT was unsuccessful which was attributed primarily to the patient having developed a large abdominal hernia. This course of RRT was abandoned and the abdominal peritoneal catheter was removed and the hernia repaired.

In August 2010, a tunneled and cuffed catheter was inserted into the patient's right internal jugular vein in order to reduce the risk of short- and long-term complications [17], such as tunnel infection and dislodgement. Both patient and family took responsibility for assessing for signs and symptoms of infection, the jugular vein catheter dressings remained intact and lumens remained capped and clamped as per current guidelines. This was dedicated as the patient's VA as a hemodialysis central venous catheter (DCVC).

In August 2010, the patient also commenced on a chronic hemodialysis schedule culminating 4.5 hours thrice weekly. It was planned that the DCVC would only serve as a bridging VA option while an AV fistula conduit was surgically created in the patient's nondominant left forearm. Establishing a mature AV fistula conduit, maintaining the patient's VA to keep it viable, and reducing the risks of VA complications, is directly aligned to patient morbidity and mortality and therefore costs to the patient, their family, the community, and healthcare services [18].

Three common surgical options for a patient's hemodialysis VA include AV fistula conduits of autonomous arteriovenous fistula (AVF), synthetic fistula predominantly composed of plastic polymers as an arteriovenous graft (AVG), or alternatively a DCVC [12]. This case report includes all three. AVFs continue to be recognized as the first choice for patients requiring repeated access for hemodialysis therapy owing to their long-term patency, lower incidence rate of functional stenotic lesion affecting the flow of the blood through the fistula conduit, thrombosis, and infection [8]. Clinical practice guidelines (CPGs) across Australasia, the United States, and Europe promote AVFs (primarily radiocephalic) to pose the least risk to a patient's mortality by maintaining superior patency and lower complication rates as opposed to AVGs or DCVC [14].

Around 75% of Australian and New Zealand patients were receiving hemodialysis through AVFs for their ESKD [3]. However, the proportion of patients commencing hemodialysis using a DCVC reportedly is as high as around 60% of Australian and 75% New Zealand patients [17], similarly this is generally reflected across Australasia, Europe, and the United States [14]. In the United States, for example, although 31–34% of patients may have maturing or functioning AVFs, around 80% of patients commence hemodialysis therapy using a DCVC as their VA [17]. This has significant implications to patient outcomes, and healthcare [15] reports patients are 2–3 times more likely to be hospitalized using a DCVC as their VA owing to infection, spend 1.7–3.7 times longer in hospital and die from septicemia compared with patients who are using AVFs. DCVCs carry the highest risk of complications including infection, thrombosis, and reduced efficiency of removal of toxins and wastes from the body [4, 8, 17].

By April 2011, the patient was experiencing poor hemodialysis adequacy, inferred by inadequate clearance of toxins and wastes during her hemodialysis therapy using her DCVC as a VA. Although she had not experienced any other DCVC-related complications, the patient and her family were resolute that their goal was to have an AVF created as her VA. The family with knowledge of the risks versus the benefits of continuing on a path of hemodialysis therapy through a DCVC agreed that an autonomous AVF still posed for her the most effective VA option to ensure the patient's long-term survival, enhancing QOL and well-being [5, 8]. Unfortunately, the primary attempt to create the patient's AVF in her left forearm had been unsuccessful. The AVF had failed to mature owing to poor arterial inflow attributed to the patient's diseased distal radial artery and the AVF was

abandoned. Atherosclerotic disease including calcification is commonly found to be pre-existing in the vessels of this group of patients, with the distal third of the radial artery most affected, resulting in many new AVFs, surgically created in patients distal forearms failing to mature [19].

In September 2011 with the patient continuing to receive her hemodialysis therapy via her primary DCVC suffered further reductions in her dialysis adequacy, a result of the inability to achieve adequate hemodialysis blood flows of 300 ml/min or greater. This was attributed to the thrombotic partial occlusion of her DCVC. The DCVC was successfully cleared with the installation of urokinase within both DCVC lumens for 2 hours and then withdrawn prior hemodialysis therapy. Although DCVCs may be intended to remain in situ as a bridging device, they often remain in use as a patient's VA for many months or even as a permanent VA remaining in place for years, as seen in this case.

In October 2011, a second attempt was made to create a proximal AVF in the patient's left upper arm utilizing the brachial artery and cephalic vein as a brachiocephalic AVF with the anastomosis in the patient's cubital fossa. Post construction, the AVF developed over 8 weeks. However, barely a short usable segment of 6 cm of the AVF vessel was able to be cannulated as the remaining length of the vessel was too deep to safely access even with the use of a longer cannula. The short superficial segment of the AVF vessel was utilized using two appropriate sized 16 g cannulas for the initial three hemodialysis therapies. During the patient's forth hemodialysis, an attempt to cannulate the vessel resulted in the needle tip perforating the back wall of the vessel and blood infiltrated into the surrounding tissue. The AVF thrombosed a few days later owing to a functional stenotic lesion occluding the arterial inflow to the patient's AVF within the anastomosis. A second stenotic area was uncovered within the outflow segment of the vessel proximal to the patient's heart. Any amenable plan to regain the functionality of the patients AVF through endovascular intervention was abandoned. With the patient's AVF being so new, thrombosis may have been exacerbated by episodes of hypotension and or hypovolemia which frequently cause AVFs to fail [7] particularly seen in cases of new, maturing AVFs and when the patient has already been receiving hemodialysis therapy via a DCVC.

The functionality of the patient's DCVC was an issue with poor dialysis adequacies and the patient and family were keen to try once again although they were conscious of the risks of further surgery and possible failure of a third AVF. In April 2012, a third attempt of a brachiocephalic AVF in the patient's right proximal or upper arm by surgically creating the anastomosis of her AVF in the right cubital fossa was undertaken. This time, the patient's AVF was left to mature for a total of 4 months. During this time the patient's AVF was not cannulated to allow maturation of the AVF vessel and decreasing the risk of complications. Regular monitoring and surveillance was initiated. The patient's AVF and DCVC remained the responsibility of everyone involved in the patient's care [8]. The family was vigilant monitoring the patient's AVF function by checking that the thrill and bruit were present over the AVF anastomosis site, along with the clinical nurses monitoring the patient's AVF. Monitoring also incorporated a nurse utilizing gray scale ultrasonography weekly to assess both the maturation of the patient's AVF and early detection of associated complications. During this period, the patient's family informed the nephrologist that they had noted the patient's primary DCVC had become dislodged and therefore required rewiring with a replacement DCVC in the same site.

As this was the patient's third attempt to establish an AVF, the patient's AVF was initially unconventionally cannulated with one needle as a routine for a number of weeks. Thus, reducing risks of trauma to the AVF vessel and arm by returning her blood from the hemodialysis circuit through alternating the use of the patient's two DCVC lumens. The technique achieved additional benefit to the patient by improving her dialysis adequacies. During a physical assessment 1 month later, along with utilization of a gray scale ultrasonography, a clinical nurse observed a stenotic lesion had developed 8 cm above the patient's AVF anastomosis. The vascular surgeon confirmed the presence of a functional stenotic lesion being 8–10 cm above the anastomosis of the AVF during a noninvasive color duplex ultrasonography. The stenotic lesion was treated using angioplasty, a fixed stent, and finally a drug-eluting stent. Drug-eluting stents implanted during percutaneous transluminal angioplasty aim to reduce the risk of functional stenotic lesions re-occurring [6].

In November 2012, the patient's AVF thrombosed followed by a 3-day delay to revive the patient's AVF complicated by a lack of available theater time. The patient was eventually moved onto another healthcare area to gain access to an operating theater. It was determined that the underlying cause of the patient's thrombosed AVF was an anastomotic stenosis. In the course of endovascular intervention, the brachial artery was perforated and the AVF was lost in favor of saving the patient.

In March 2013, the patient and family agreed to revisit the patient's right arm for a VA, this time using the brachial artery and basilic vein for an AVF. Being the fourth attempt at creating a viable AVF, initially the patient's brachiobasilic AVF developed slowly and cannulation was not attempted. The vessel was deep and required further

surgical intervention to transpose the basilic vein. After 3 months of regular monitoring and surveillance, a functional stenotic lesion was detected by a clinical nurse on physical examination and gray scale ultrasonography approximately 4–6 cm above the anastomosis. This was confirmed by the vascular surgeon utilizing color duplex ultrasonography. Unfortunately, the AVF thrombosed before an angioplasty was performed and any attempt to revive the AVF has been abandoned for any time in the near future. The patient continued to dialyze through her DCVC obtaining adequate though not optimal hemodialysis clearances of her body's toxins and waste products.

In October 2013, it was time to change strategy and place an AVG in the patient's right thigh. Previously avoidance of placing an AVG in the patient's thighs was attributed to her experiencing severe peripheral neuropathy in her lower limbs and the patient's healthcare team comparing the etiology of fistula conduits. Synthetic AVG conduits are more prone to infection and unpredictable failure from neointimal hyperplasia compared to that of AVFs [8]. A combination of using a synthetic graft along with the patient's already diseased vessels including pathological irregularities such as arterial medial fibrosis and calcification reduced the likelihood of the patient's synthetic AVG survival [2]. The patient's right thigh AVG was not cannulated for 8 weeks after surgery and then only using the venous return limb of the AVG loop as the patient's surgical wound over the arterial limb of her loop was slow to heal. The patient's hemodialysis therapy was continued for another 6 weeks by cannulating with one needle into the inner venous limb of the AVG loop for removal of blood and returning the patient's blood via her DCVC.

The patient's leg wound healed and at 4 months after her surgery, two cannulas were used one in either side of the AVG loop with the second cannula returning the patient's blood from the hemodialysis circuit. The patient had commenced warfarin prophylactically at the time of surgical placement of her AVG and was experiencing regular episodes of prolonged bleeding from cannulation sites after removal of her cannulas at the end of hemodialysis therapy sessions. The patient had similarly experienced constant bruising secondary to cannulation of the AVG in her right thigh. The warfarin was ceased after one final incidence when the patient required transferring to the hospital's emergency department post hemodialysis, having continued to bleed from a cannula site for 6 hours. Follow-up surveillance colored duplex ultrasonography had revealed a thrombus that continues to be monitored within the venous anastomosis or outflow of the patient's AVG circuit. The patient's therapeutic warfarin regime was replaced with daily clexane injections (enoxaparin sodium), fish oil capsules (omega-3 polyunsaturated fatty acids), and aspirin tablets (acetylsalicylic acid). No further episodes of prolonged bleeding or excessive bruising have re-occurred.

By October 2014, the patient's hemodialysis adequacies improved and the patient correspondingly reporting enhanced QOL and well-being. The patient's DCVC remains in situ with no immediate plans for its removal and continues to be used as a VA routinely for at least one of the patient's hemodialysis therapies second weekly. The practice of the patient having a DCVC as a secondary VA option continues to enable resting her AVG and limb if cannulations are unsuccessful, should the AVG sustain trauma, requires intervention or fails.

Discussion

Changing demographics have resulted in greater numbers of elderly populations who reach ESKD having comorbidities. Increased complexity in patients requires extensive patient assessment to determine the most appropriate VA for their individual circumstance [1] while balancing the risks versus the benefits to the patient. Although an autonomous arteriovenous fistula (AVF) is regarded as the first choice for a patient's VA [8], this case demonstrates that effective assessment may lead to alternative VA routines being adopted including a mix of AVF and DCVC, AVG and DCVC. A patient's AVF should be surgically placed well in advance of the patient commencing hemodialysis therapy and will depend on patient-related factors and their local facilities [17]. UK guidelines recommend the surgical placement of a patient's AVF by 3 months, but no earlier than 12 months prior to the patient's anticipated start of hemodialysis therapy allowing time for any necessary revisions of the patient's AVF [9]. Australian and New Zealand clinical practice guidelines (CPG) advocate that when a patient is reaching the late stages of CKD 3b/4, it is crucial to have a planned predialysis pathway including patient and family/carer education, vascular assessment, creation of a vascular access, and subsequent maturation time [17]. Late referral restricts the opportunity for patient and family/carer education and may limit meaningful involvement in decision making regarding treatment options influencing patient satisfaction, adherence to treatment, and QOL of both patient and family/carer [10].

Conclusion

There have been mixed reports on the viability of AVFs for elderly patients compared with AVGs and DCVCs. Current evidence remains unclear as to what is the best option of VA for an elderly patient to provide optimal hemodialysis therapy and patient outcomes. Issues that are

key elements in decisions regarding the most advantageous options of VA for an individual include the patient's life expectancy, QOL goals, and well-being. Equally important in the multidisciplinary healthcare team are the patient and their family and/or carers. The responsibility of a patient's VA is the responsibility of all those involved in and with an interest in the patient's care. Healthcare education for patient and family/carers, which supports their decision-making processes, may be compromised when time is not available and foreseeable procedures are not adequately planned.

Postscript

In January 2015, sadly this patient passed away. Incidentally, her AVG was still functioning before she passed. While reflecting back, I question what can other people learn from this patient's journey? Around 4 years ago I had asked this patient what did she really need and her answer was "I want to live, not just to stay alive but to live, to be there for and with my family, particularly for my two grandchildren." Therefore, the patient's goal was set to fulfill her expectations. My reply back then was "okay, let's work together as a team to do just that."

Today the patient's sister visited the hemodialysis unit, where the patient had received her hemodialysis therapy and care. She said she was "so grateful for the care her sister had received" and spoke about the many ways that the patient and her family were welcomed and how their opinions and needs were respected and embedded into the patient's care. Through allowing patients and their family to have a voice, to set their goals, and incorporating the patient and their family as team members in healthcare we effectively implement family nursing. By being with the family we can learn about what is important to them as a family, the importance of providing support for them to live their goals, obtain QOL, and well-being, rather than the caring for the patient with a system aim of merely remaining alive.

Conflict of Interest

None declared.

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