Arteriovenous Fistula for Haemodialysis: the role of Surgical Experience and Vascular Access Education

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Editorial

Arteriovenous fistula for haemodialysis: The role of surgical experience and vascular access education

Fístula arteriovenosa para hemodiálisis: el papel de la experiencia quirúrgica y la educación sobre el acceso vascular

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The population of end-stage renal disease (ESRD) patients is rising all over the world.[1,2] In 2009, more than 350,000 patients in the United States (US) received in-centre haemodialysis (HD). Vascular access procedures are one of the most commonly performed surgeries in the US, with approximately 500,000 procedures performed annually.[3] Treating ESRD patients cost the US over $40 billion in public and private funds in 2009.[4] In Europe, more than 550,000 ESRD patients received renal replacement therapy (RRT) in 2010.[5] The prevalence of RRT per million population (p.m.p.) on 31st December 2009 was the highest in Portugal (1507 p.m.p.), Belgium, French-speaking (1193 p.m.p.) and Spain, Catalonia (1160 p.m.p.).[6]

Despite an increase in the number of kideny transplants, which is the best treatment of ESRD patients, chronic HD is still the main therapy.[1] Autologous (native) arteriovenous fistula (AVF) provides the best access to the circulation because of low complication rate, long-term use and lower costs, compared to arteriovenous graft (AVG) and central venous catheter (CVC).[1,7,8] The cost of vascular access care was more than five times lower in those who had begun treatment with functioning AVF, compared to those who were treated with a graft or permanent catheter.[9] The main factor limiting fistula use is a high rate (up to 70%) of primary failure.[10] To avoid unsuccesful attenpts, guidelines recommend preoperative duplex ultrasonography (DUS) and the use of vessels with a diameter able to maintain sufficient blood flow and fistula maturation.[1,7,8] The impact of vessel diameter was evaluated in numerous studies.[11–14] In some studies, artery and vein diameters below 2 mm were predictors of high incidence of early thrombosis or failure of maturation, and some authors recommend to set a cut-off size of the artery and the vein. The most widely mentioned recommendation is: artery diameter $\geq$2 mm and vein diameter $\geq$2.5 mm[15–18] or vein diameter $\geq$3 mm.[19] After anastomosis construction, an increase of flow (10–20 times) and vessels dilatation are necessary to be functional. The quality of the vessels is also important and some studies underline that the capacity of vessels' dilatation (vascular compliance) is more important than the vessel diameter alone.[20–22] There is no simple and reliable test for determining vascular compliance preoperatively. The predictive value of the arterial resistance index (RI) is uncertain.[7] In one study, preoperative RI > 0.7 in the feeding artery indicates that arterial blood flow will not

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increase sufficiently, thus reducing the chance of successful AVF.[23] Two other studies found no difference in fistula outcome for hyperaemic response.[18,24] Preoperative venous size and, especially, vein distensibility are also difficult to measure.[25] Planken et al. revealed daily variations in forearm venous diameters, which should be taken into account when defining cut-off diameters prior to vascular access surgery.[26] Lockhart et al. recommended using a venous tourniquet in preoperative DUS which increases the number of patients eligible for forearm fistulas without decreasing the adequacy rate.[27]

In some studies, older age was a predictor of fistula failure,[10,18,28,29] but other authors did not find this relationship between age and failure of fistula.[30,31] A lower percent of functional AVFs was found in females.[18,19,28,32] Furthermore, some studies found no differences in fistula success regarding gender.[31,33] Diabetic patients were marked as one of the risk groups of patients.[34,35] In contrast, there was no negative correlation regarding diabetes and AVF success in some studies.[36–38]

In an ideal situation, patients should be referred to a surgeon a few months before starting HD. A detailed medical history (presence of diabetes, hypertension, peripheral ischaemia, amputation, coronary or carotid surgery, pacemaker, stroke, cannulation of the central veins etc.) and physical examination of the both upper extremities are necessary. Blood pressure measurement on both arms may reveal proximal artery stenosis if there is more than 20 mmHg difference. Arterial pulses, Allen test, patency of the deep and superficial veins should be checked. According to the current guidelines, preoperative DUS should be performed and, if possible, vein mapping as well. DUS is especially important in those cases of invisible superficial veins, atherosclerotic disease and prior cannulation of the central vein. Some authors recommend that DUS evaluation should be performed by the surgeon constructing the AVF.[39,40]

Who should perform angioaccess surgery?

The surgical challenge is to successfully create a functioning arteriovenous access suitable for HD therapy.[41] Angioaccess surgery is not restricted to vascular surgeons. All over the world, other specialists also perform this operation (urologists, general and cardiothoracic surgeons). A common "conversation piece" among most nephrologists is the frustration they face in feeling at the mercy of the surgeon(s) in their institution.[42] Ortega Suárez stated that one of possible reasons why graduate doctors in Spain were less and less interested in choosing nephrology was dependence on other departments (e.g. vascular surgery).[43] In the study of Roca Tey, more than half of the HD centres considered the support from the surgical services to be insufficient.[44] Because of the surgeons' disinterest, nephrologists from some centers started to create AVFs.[35] They construct about 85% of the AVFs in Italy and about 25% of the AVFs in Japan.[45] The nephrologist group in one centre in Spain achieved results comparable to the surgical group regarding the percentage of primary failures and AVFs survival. The waiting time for surgery was reduced from 103 days in general surgery group to 21.5 days in nephrology group. The percentage of patients initiating dialysis without an AVF was also reduced from 63% in general surgery group to 19% in nephrology group.[46]

According to Davidson et al., the issue is not who places the access, but who does it right.[47] Vascular access procedures should be restricted to surgeons with demonstrable interest and experience, and o those that are familiar with the basic principles of HD and the problems of patients on HD. All required surgical procedures have to be on the surgeons' repertoire, especially follow up after interventions and dealing with complications. Vascular surgeons seem to be the best option in these circumstances. There are also opposite opinions. Jiménez-Almonacid et al. reported that angioaccess surgery, as an outpatient surgery, was included in the general surgery unit and was performed by not exclusively dedicated surgeons.[48] In some centres, vascular access procedures are considered to be minor procedures and are entrusted to junior surgeons.[49] Access operations should not be the tail-light of the schedule in the operating theatre because time pressure prevents meticulous and patient surgery.[50]

The role of surgical experience and dedication to angioaccess surgery

It is estimated that 25% of all patients starting HD will die because of an inadequate vascular access.[51] This information must be a warning to all participants involved in the care of ESRD patients. The relative risk of death increases by two to three times in case the patients started dialysis with CVC, compared to those using an arteriovenous access.[52] Long-term dialysis with tunnelled cuffed catheters is associated with a two-fold to three-fold increase in the death risk, a five to ten-fold increased risk of a serious infection, increased hospitalization days, decreased likelihood of adequate dialysis and an increased number of vascular access procedures.[53] The use of tunnelled catheter at any time is associated with an increased risk of death. This effect increases with the duration of catheterisation.[54] Therefore, special effort should be made to avoid CVC as much as possible.[55] Goodkin et al. concluded that the greater use of catheters/AVGs and markedly lower use of fistulas in the US may be killing patients.[56] Nephrologists and surgeons are ethically obligated to systematically explain to patients the harms of tunnelled cuffed catheters.[53]

Many authors agree that the surgical skill is one of the important factors affecting AVF surgery success.[44,49,57–59] Numerous studies revealed surgical experience as a statistically significant predictor of success in angioaccess surgery.[60–63] Puskar and al. have shown that insufficient surgical experience contributed to AVF failure.[64] Huijbregts et al. concluded that the probability of primary failure is strongly related to the centre of access creation, suggesting an important role for the vascular surgeon's skill and decisions.[65] The great variability in results regarding vascular access was found in a single autonomous community, with an almost uniform management model. The authors concluded that the results depended on the type of centre where the patient underwent dialysis, the vascular radiology service, and especially the surgical service responsible for the vascular access.[66] In the study of O'Hare et al. ($n = 1114$), AVF placements were more than

three times greater at high volume centres (>30 procedures per year) than at low volume centres.[67] Fassiadis et al. suggested that the placement of AVF should be performed by the most experienced member of a team dedicated to vascular access creation, or at least under their supervision.[68]

There are also opposite opinions. Data reported by Gundevia et al. and Weale et al. suggest that trainees are able to perform AVF procedures effectively with adequate supervision and allocation of appropriate cases. The fistula patency did not differ after creation by trainees as opposed to creation by senior consulting surgeons in those two single-centre studies.[69,70] Weale et al. suggest that vascular access surgery can be utilized as a training operation.[70] Strong opposite findings were found by the Chemla's team in London. They performed 552 AVFs in 4 years and found that the results of experienced consultant were superior to that of the junior surgeons performing surgery under his direct supervision. The primary success rate in the consultant group and junior surgeon group was 94.2% and 81%, respectively ($p < 0.01$). Furthermore, primary and secondary patency rates at 22 months showed statistical difference ($p < 0.025$) between the two groups as well.[68] During the analysis of AVF versus AVG use among new HD patients in Europe and the US, Pisoni et al. found that the likelihood of the AVF use was 40% lower in dialysis unit in which surgery trainee either performed or assisted permanent vascular access placements.[63]

The impact of haemodialysis vascular access training was researched in the Dialysis Outcomes and Practice Patterns Study (DOPPS). In the DOPPS the risk of primary fistula failure was 34% lower when fistulas were placed by surgeons who had created at least 25 fistulas during training ($P = 0.002$). In the US 54% of access surgeons responded that degree of emphasis given to creating arteriovenous vascular access was "not at all emphasized" or "somewhat emphasized" compared with other surgical training.[71] In contrast, only 13% of the operators in Japan and 16% in Italy, the nations with the highest prevalences of fistulas, gave either of the two responses indicating low training emphasis on access surgery.[56]

The surgeon should put additional time and effort into constructing a functional fistula in the first attempt. In the study of Canadian authors with a large number of patients ($n = 5924$), second access creation was associated with an increased risk of sepsis. Early access creation (at least 4 months before starting HD) was associated with a 43% of reduction in the risk of sepsis and a 24% reduction in the risk of death.[72] Patients with a history of failed access had 2.56 times the risk of failure compared with patients with a first access in one study.[73] In the study of Rodriguez et al., two-thirds of patients in whom the first AVF developed successfully did not have any subsequent failure, whereas initial failure increased the risk of subsequent failure by a factor of 2–8.[57]

Asif et al. have shown that 90% of the patients with CVC and previously failed arteriovenous access, who were evaluated with vascular mapping, had suitable veins for the construction of an AVF. Despite aggressive educational efforts, 37% of patients with CVC refused permanent access surgery in that study.[41] Other authors also mentioned that patients were prone to refusing surgery after failed prior access.[44,74,75] Operator's experience is also important in other VA procedures. In the catheter use, the implantation team (nephrologist, surgeon, nurse) is more important for results than the technique of implantation.[76]

Despite preoperative DUS, intraoperative exploration still remains crucial. Saucy et al. state that intraoperative surgical assessment of the vessels is the last possibility to choose the right strategy.[17] Lauvao et al. stress that surgeon's judgement remains extremely important.[37] Konner underlines that a vascular access surgeon has to be aware of the anatomical, physiological, haemodynamic, and mechanical principles underlying the procedure and this has to be combined with manual skills, experience and creativity. Even minimal errors, for example, minor narrowing in the beginning of the anastomosed vein, will eventually translate into late stenosis. Thus, not only early, but also late failure reflects on the quality of the vascular access surgeons.[77] Nephrologists should strive to build a strong relationship with a limited number of access surgeons and the choice of access surgeon must be driven by the outcome, and be independent of economics and local politics.[41,78–80] Nguyen et al. suggest that surgery continuous quality improvement data on AVF outcome should help with surgeon selection, based on the ability to create a mature AVF in >50% of patients.[79]

Vascular access education

Constant effort should be put into continuous education of all participants involved in the care of ESRD patients. In order to increase interest and the understanding of the need for autologous AVF, patients should be exposed to large amounts of discussion and persuasion. Pre-dialysis patients have to take an active role in the defence against unnecessary venipuncture.[81] The implementation of a vascular access quality programme has improved access care and resulted in placement of more autogenous AVFs.[75,82,83] Education of all the members in the multidisciplinary team (including patients, their families or caregivers and family doctors) and the implementation of an optimized care protocol are especially important in centres with a low rate of native AVF and a high rate of primary failure. In a large scale multi-centre study of Nguyen et al., it was reported that the success of the sponsored multidisciplinary educational meetings was indicated by a dramatic increase in AVF use, without substantially increasing catheter use.[79] Establishing of vascular access centres (VAC) with dedicated and educated multidisciplinary access team provides the best access care. In the study of Mishler et al. dedicated outpatient VAC decreases hospitalization and missed outpatient dialysis treatments.[84]

Conclusion

Angioaccess procedures should not be considered as minor procedures. These operations must be restricted to surgeons with demonstrable interest and experience, or they should at least be carried out under their supervision. Preoperative DUS evaluation should become a routine tool for all vascular access surgeons. Vascular surgeons should be involved in vascular access care as much as possible. Constant effort should be put

into continuous education of all participants involved in the care of ESRD patients.

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