References


To stent or not to stent: is there a role for vascular endoprostheses in haemodialysis shunts?

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Introduction

Malfunction of haemodialysis access is frequent and requires an adequate diagnostic and therapeutic approach. An increasing number of patients are joining chronic dialysis programmes: Burger et al. reported that 150–200 individuals per million are involved in Western countries [1]. Despite refinement of dialysis techniques, prognosis of shunt function is still limited. No more than 15% of shunts function well in the long term [2] and even primary patency rates of non-complicated haemodialysis fistulae leave much to be desired. Keller et al. found a 1-year primary patency of 65% for Brescia–Cimino AV fistulae and 50% for graft shunts [3]. For Brescia–Cimino shunts, primary patency after 2 and 4 years was 60 and 45% respectively; for graft shunts it was even lower with 43% and 10% [3]. If cases with shunt repair were included, overall patency was slightly higher. Keller reported 70% of overall patency after 1 year, about 60% after 2 years and 40–60% after 3 years of follow-up. A significantly better overall patency for Brescia–Cimino fistulae was found after 4 years with 55% versus 29% (graft shunts). Similar overall patencies were reported by other groups such as Palder and co-workers [3,4]. Shunt stenosis has been found to be an important cofactor for shunt thrombosis if it goes undetected and
Percutaneous balloon angioplasty

Percutaneous balloon angioplasty (PTA) has previously been recommended for a limited number of indications, mainly short segment stenosis [6,7]. New developments and growing experience in that field, however, have enlarged its indications as an alternative to surgical revision. Numerous publications exist on PTA of haemodialysis shunts. In larger series involving more than a hundred interventions [6,8–10], similar high technical success rates ranging from 82 to 94% [6,8–11] were reported. Follow-up patency, however, showed a high rate of reobstruction and failure in most series reported. Gmelin and Karnel found 6-month, 1-year, and 2-year patencies of 75, 62, and 34% [9] for stenoses and 73, 54 and 14% for occlusions. Glanz and co-workers [6] reported on a patency on 57% (6 months), 45% (1 year) and 24% (2 years). Neither group used life-table analysis for evaluation of their data. This was done by Beathard [8]; however, he reported a cumulative patency of 61% after 6 months, 38% after 1 year and 22% after 2 years. Although these results may look disappointing, PTA in failing haemodialysis fistulae is able to improve overall patency of failing shunts. Bohndorf and co-workers [10] were able to achieve an overall patency for both failing PTFE shunts and Brescia–Cimino fistulae that corresponded well to the 1- and 2-year overall patency of a general shunt population after primary shunt surgery [3,4]. This was in contrast to the poor primary patency for this high-risk subgroup of failing haemodialysis fistulae [10] which was considerably lower compared to a general shunt population [3]. Therefore, an acceptable overall function rate can be expected even for complicated shunts after percutaneous revision. Repeat PTA does not compromise patency rates. Beathard found similar results with no relation to the first, second, or third PTA performed [8].

Why to use alternative percutaneous techniques?

Two main conclusions can be drawn from the literature on percutaneous therapy on shunt stenoses:

1. Balloon angioplasty offers a high technical success and a low complication rate.
2. Follow-up results are moderate to poor related to primary patency. Recurrent intervention, however, is possible and offers the chance to achieve satisfactory overall patency. Restenosis is due to excessive neointimal hyperplasia. It is more pronounced than in arteries.

The results of surgical revision, however, are not better compared to balloon angioplasty [11]. Nevertheless, some problems persist. The high technical success rate reflects only part of the real situation. Patients that are referred to percutaneous treatment are mainly preselected. Therefore, they present with a lesion that is more or less amenable to percutaneous therapy. Technical success of PTA, however, is determined by morphological criteria of each individual lesion, and of course there are some subtypes of lesions that are difficult to treat:

1. Highly rigid concentric stenoses are more frequently found in haemodialysis shunts than in arteries and do not respond well to balloon dilatation.
2. The recoil type of stenosis opens sufficiently during balloon dilatation but collapses immediately after deflation. Balloon dilatation alone is mostly insufficient to keep these lesions open.
3. Shunt flow frequently leads to venous enlargement and elongation that may result in a kinked stenosis. These lesions also respond well to balloon dilatation, but after deflation, long-term success is minor.
4. Central venous obstruction shows a tendency to recur early [8,12,13].
5. Chronic venous occlusion is more difficult to treat than stenoses.
6. Acute thrombosis of haemodialysis shunts show low technical success rates and follow-up patency.

New techniques should, therefore, offer technical solutions for these complex types of lesions and/or might increase the long-term patency.

Endovascular stents

Endovascular prostheses were introduced to percutaneous treatment of arterial disease in the late 1980s. They are useful, especially for complex iliac artery lesions. Early reports, however, did not clearly define the role of stenting in angioplasty. While Dotter and Judkins focused on its potential benefit for the technical postangioplasty result [14], early comments speculated on its beneficial role in the prevention of restenosis [15]. Subsequent reports demonstrated the advantages of stenting in the treatment of complex arterial lesions or complications such as dissections. No clinical proof has been provided, however, to document that restenosis rate is substantially decreased by additional use of stents in arteries. There is only a single randomized follow-up study by Richter and co-workers, showing that stenting of iliac artery stenoses may offer an advantage over balloon angioplasty alone [16].

Therefore the current role of stenting in arteries is mainly limited to cases in which the technical results of angioplasty have to be improved.

Stents in shunts: technical results

Similar problems arise with use of stents in haemodialysis fistulae. Although several types of metallic endoprostheses have been applied in the venous system and
particular for shunt stenoses and occlusions [17–20], indications for stenting remained ill-defined. In our opinion the indication is mainly based on technical considerations. Stenting should be only done if PTA fails or is complicated (Table 1).

If limited to selective cases, stent placement has a considerable impact on the technical success of percutaneous therapy, since it enables rational treatment of lesions that are otherwise resistant to balloon angioplasty.

Stents are helpful to stabilize kinked and collapsing stenoses, help to seal dissections or circumscribed perforations, and may be utilized to establish patency of chronic venous occlusions. Results post-PTA of highly rigid stenoses can be improved by stent implantation. In addition, stents are helpful in remodelling venous outflow in special situations.

**Stents in shunts: follow-up patency**

Stents are, however, not an appropriate tool to prevent restenosis. In our own experience with more than 60 cases over a period of 7 years, we found that the rate of restenosis is very similar to that after PTA without stent placement [21]. It has to be stressed, however, that the stent technique had been limited to shunts in which angioplasty failed. In most cases, shunt patency would not have been maintained without stenting. Beathard and co-workers did not find either a long-term benefit of Gianturco stents over balloon dilatation of stenosed venous anastomoses of Goretex grafts [22].

There is, however, an important exception: although restenosis is also frequent in central venous stents, primary patency approximates that of peripheral venous stenoses [23]. Therefore stents in central veins can reduce the tendency of central venous lesions to recur that is regularly seen after simple PTA. Even if restenosis occurs, revision can be readily performed by balloon dilatation or atherectomy of the stented area. This procedure may achieve high overall patency rates both for central and peripheral stents in shunts. It is better for central lesions, reaching 100% 2 years after intervention in our own experience [23].

In conclusion, stent application should be limited to special lesions that are technically not amenable to PTA alone. In those lesions, however, application of stents can help to overcome an otherwise serious situation, and preserve shunt patency. Except for central venous obstruction (Figure 1), an improved long-term primary patency is not likely to be achieved, but

**Table 1. Indications for stent placement**

<table>
<thead>
<tr>
<th>Primary</th>
<th>Secondary</th>
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<tr>
<td>Central venous obstruction</td>
<td>Kinked stenosis</td>
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<tr>
<td>Dissection</td>
<td>Collapsing stenosis</td>
</tr>
<tr>
<td>Circumscribed perforation</td>
<td>Resistant stenosis</td>
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<tr>
<td>Remodelling</td>
<td>Chronic venous occlusion</td>
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Fig. 1. a Self-expanding Wallstent; b high-grade central venous stenosis of left innominate vein (arrow) in a dialysis patient; c after stent placement (arrows) sufficient drainage is re-established.
an adequate overall patency can be accomplished by percutaneous reintervention.

Caveats

A general finding is true for both arteries and veins: the larger the diameter of a stented vessel, the better the follow-up results. Therefore use of stents should be applied with restraint in small forearm veins but may be more liberally applied in upper arm and central venous lesions. Furthermore, stent placement in the puncture area of Brescia–Cimino shunts should be avoided, since experience with stented vessels that are regularly punctured is lacking. The stented segment should, in any case, be kept as short as possible.

What type of stent should be used?

The choice of a suitable type of endoprosthesis depends mainly on its anatomical location. For antebrachial and brachial use, superficial location of the stent requires a flexible and elastic stent that is strong enough to withstand external pressure, but recoils to its primary shape after compression has been released. Movement of the arm may lead to considerable bending of the veins, especially in the elbow region, and therefore a flexible endoprosthesis is required. The expanding pressure of the implant should not be too tense to avoid damage to close structures such as nerves.

Therefore, in our opinion the self-expanding Wallstent type is the most suitable stent in that location. Modern Nitinol stents that will come into clinical use in the near future may also fulfil these criteria.

For central veins the stents should be available in large diameters of 10–16 mm or for caval lesions up to 20 mm in diameter. Flexibility and expansion strength are not always mandatory in this location but characteristics mainly depend of the length, shape, and type of the lesion treated.

Safe local fixation of the stent is the most important prerequisite to avoid central stent embolization. In our own experience even chronic venous occlusions will undergo further enlargement of the venous lumen after stenting. In this case a self-adjusting stent such as the Wallstent or Nitinol Stents seem advantageous to avoid subacute stent dislocation and central embolization.

Future developments

Excessive neointimal growth remains the most challenging problem in stented shunt veins, while early thrombosis is relatively rare with this type of lesion. High flow seems to be an important cofactor of that problem since stents in non-shunted veins rarely develop neointimal restenosis [24]. As for stents in arteries, different strategies may be developed to overcome this basic problem. These include covering and coating of stents, adjunctive therapy such as active drug-releasing coating, microporous balloons or gene therapy. These developments are likely to parallel those under way for arterial stents.

Conclusion

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Conclusion

Stent technique is an important adjunct to percutaneous therapy of failing haemodialysis shunts. It should be considered as a useful tool to improve the technical results of angioplasty. We have to keep in mind that reobstruction after intervention is mainly the result of the non-physiological high-flow situation in formerly low-flow vessels. Timely intervention is therefore crucial for shunt maintenance and protection strategies—and stents should be part of this intervention.

References

The loin pain haematuria syndrome

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Loin pain haematuria syndrome (LPHS) is a descriptive diagnosis given to patients with recurrent attacks of unilateral or bilateral loin pain that may be accompanied by microscopic or even macroscopic haematuria, in whom no cause has been found after comprehensive investigation [1]. Abnormalities on angiography have been reported in some cases and renal histology may reveal signs of vascular damage. Prominent deposition of C3 in arterioles is said to be typical. The pathogenesis is not understood but vaso-pasm has been proposed. The prognosis for kidney function is excellent and the condition does not lead to end-stage renal failure. The pain is very severe, leading to the requirement of powerful analgesics. Continuing symptoms have led to interventions including renal denervation and even nephrectomy. Renal autotransplantation has been recommended as a 'nephron-sparing' solution. This is the orthodox view which must be questioned.

Is LPHS a renal disease? The pathological and radiological features are neither specific nor constant. Neither Leaker et al. [2] nor Jones [3] found the arteriographic abnormalities described by Burden et al. [4] in their patients who underwent selective renal angiography. They did, however, see arterial and arteriolar lesions and evidence of glomerular bleeding in 2/3 of their cases. C3 is found in the arterioles of normal kidneys but the deposition is said to be more pronounced in patients with LPHS. 'Blind' review by two histopathologists of the biopsies of 52 of Jones' 56 patients revealed unequivocal abnormalities in 18, possible abnormalities in 14, but in 24 both histologists regarded the biopsy as normal [3]. So at best one can say that there is some evidence of renal injury in some patients with LPHS.

What is not explained is why this condition causes those who suffer it such severe chronic loin pain not seen in other more specific renal diseases. Patients with very severe acute glomerulonephritis or renal vasculitis occasionally admit to some loin discomfort. Very few patients with adult polycystic kidney disease, whose kidney capsules are stretched and whose renal parenchyma are grossly distorted, suffer pain but rarely does its control require resort to opiate analgesics. Reflux nephropathy, ischaemic renal disease, and renal-vein thrombosis may all present with pain but not of the unrelenting sort reported by patients with this condition. The only equivalent renal pain is that caused by renal colic. If major renal parenchymal conditions seldom elicit such pain how can the minimal pathology of LPHS do so? If it is a vascular disorder why do patients with accelerated-phase hypertension, haemolytic uraemic syndrome, and cholesterol emboli not experience it? Why is it so episodic? Why is it so frequently unilateral only moving to the contralateral side after some procedure to the first side? How is the pain transplanted to the iliac fossae after renal autotransplantation? There is, it seems, something singular about this pain or something special about those who suffer it. There may even be a clue in the fact that this appears to be a condition of North America, Britain and Australia.

Lucas et al. [5], aware that in the original report of the condition three of the patients were described as 'anxious, introspective, demanding of medical attention and occasionally fabricating evidence,' performed a detailed psychiatric assessment of 15 of their patients. They noticed that 7 of 15 had paramedical backgrounds; 9/15 had had at least one previous episode of severe depression. Seven related the onset to a