OPERATIVE TREATMENT OF SEPTIC HEMORRHAGE DUE TO DIALYSIS ARTERIO-VENOUS FISTULA*

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The number of hemodialyzed patients in western countries is growing consistently. Septic complications of vascular access obtained with artificial prostheses are a significant therapeutic problem. Septic bleeding from infected arterio-venous fistula is a life-threatening condition.

The aim of the study was to evaluate the results of treatment for septic bleeding from arterio-venous fistula. Data was gathered at the General, Vascular Department at Central Clinical Hospital Ministry of Internal Affairs.


Results. All of the patients with septic bleeding had arm fistula due to the employment of vascular prostheses. Successful dialysis fistula reconstruction was performed in 5 of 6 patients. Reconstruction of the brachial artery was carried out in the sixth patient. In all cases, we used segments of autogenous saphenous vein as reconstructive material. Patients with septic bleeding were significantly more likely to have undergone a vascular access operation or fistula reconstruction, in comparison to the group of non-septic patients.

Conclusions. The highest risk of septic bleeding as a result of dialysis fistula infection is observed in patients with fistulas preformed with vascular prosthetic grafts. Patients operated due to septic bleeding have the possibility to maintain existing vascular access for dialysis. Our results indicate that the best material for infected dialysis fistula reconstruction is autogenous saphenous vein.

Key words: Arterio-venous fistula, septic bleeding, vascular access for dialysis

End-stage renal insufficiency leads to significant impairment in immunological system function and a ~300-fold increased risk of death associated with sepsis, in comparison to the general population. Infections of vascular access pathways for dialysis are an important problem in kidney replacement therapy. Bacteremia and sepsis are secondary causes of death in patients with end-stage renal insufficiency and are responsible for 12-36% of all deaths in hemodialyzed patients (1, 2). It is estimated that 48-73% of all bacteremia in dialyzed patients is related to vascular access infections (3). Immunity impairments and repeated fistula cannulation or catheter insertions to central veins for dialysis favor infec-

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tious complications. Infections are most frequent in patients dialyzed with central venous catheters used for vascular access. Use of a central venous catheter is a general risk factor for infection, but infectious complications are also observed in fistula-dialyzed patients, especially those with prosthetic graft fistulas.

Infections of arterio-venous fistulas limited to skin and subcutaneous tissue may be successfully treated conservatively with local antiseptics, together with systemic antibiotic therapy. However infection that inflicts anastomosis and/or fistula may lead to septic bleeding and sepsis, both life-threatening conditions.

The aim of the study was evaluation of septic bleeding treatment evoked by arteriovenous dialysis fistula infection.

MATERIAL AND METHODS

Between January 1, 2004 and December 31, 2008, we performed 354 arterio-venous fistula operations, including primary and secondary fistula creation as well as reconstructive procedures. We used antibiotic prophylaxis (first-generation cephalosporin, 1.0 g i.v. cephasolin) in several circumstances. The indications for the prophylactic antibiotic therapy were: prosthetic graft implantation, history of diabetes mellitus, immunosuppressive therapy, and prolonged operative period over 1.5 hrs. In other clinical situations, we did not use any antibiotic prophylaxis. We compared patients with AVF septic bleeding to patients without this kind of complication. Table 1 shows the characteristics of particular groups of patients. Gender, age, frequency of diabetes mellitus, occurrence of immune disease, and number of attempts at vascular access for dialysis constructions and reconstruction were compared between these groups.

Every patient with septic bleeding was qualified to an emergency operation. During the operation, bleeding was restrained, a smear from the infected area was taken for bacteriological tests, and fistula reconstruction was performed. Our goals were to prevent the recurrence of septic bleeding, to save well-functioning vascular access for dialysis, and to avoid temporary central vein catheter insertion. Autogenous saphenous vein was the preferred material for fistula and artery reconstruction. Empiric antibiotic therapy with vancomycin and 3rd generation cephalosporin was used. After obtaining antibiograms, the treatment was modified if necessary and continued for at least 2 weeks.

Statistical analysis between groups was performed with the chi-square test.

RESULTS

Infectious complications of arterio-venous fistula leading to septic bleeding occurred in 6 patients; the mean time between last vascular access operation and septic bleeding was 8.5 ± 6.1 months. All of the patients suffering from septic bleeding had arm fistula with at least a segment created with a prosthetic graft. Among 348 patients without history of septic bleeding, 267 had totally autogenous arterio-venous fistula, and 81 patients (23.3%) had prosthetic graft fistula. Patients with septic bleeding had significantly more vascular access operations (3.5 ± 0.55) in comparison to non-septic patients (1.6 ± 0.28) (p < 0.05) and underwent significantly more fistula recon-
Operative treatment of septic hemorrhage due to dialysis arterio-venous fistula

Structive operations (1.5 ± 0.76 vs 0.7 ± 0.16, respectively) (p < 0.05). Septic bleeding results in a 15 ± 4% (range: 12-24%) decrease in hemoglobin level as compared to the last blood examination before bleeding. On average, a transfusion of 2.3 blood units was required during the postoperative period.

All septic bleeding occurred at least 1 month after the last vascular access operation. In 5 out of 6 cases, septic bleeding was associated with isolated prosthesis infection located in the middle segment of dialysis fistula, the part normally used for vascular access cannulation. In one case, septic bleeding resulted from infection of the anastomosis between the brachial artery and fistula prosthetic grafts. A segment of autogenous saphenous vein was used in reconstructive operations to create anastomosis with non-infected segments of fistula or brachial artery. In cases of dialysis fistula reconstruction, a segment of saphenous vein was de novo tunneled in subcutaneous tissue, and infected segments of prosthesis were removed through separate incisions. In 5 patients, vascular accesses were successfully preserved with the above-mentioned procedure. In one patient with infection inflicting the brachial artery only, artery reconstruction was possible, and dialysis fistula was therefore sacrificed. Ultimately, the applied surgical treatment was successful in all cases. Patients with anastomosis infections required re-operations on the first postoperative day due to hematoma located in close proximity to the reconstructed brachial artery. The hematoma was drained.

We did not notice any cases of recurrent infection. Reconstructed fistula patency was 100% and 60% after 1 and 12 months, respectively. The most frequently isolated pathogens were Staphylococcus aureus (4/6) (methicillin-resistant strains in three cases) and Staphylococcus epidermidis (2/4). Table 2 presents characteristics of patients with septic bleeding due to arterio-venous fistula infection.

DISCUSSION

Usage of artificial vascular prosthesis in humans is associated with increased risk of life-threatening septic complications. In patients with end-stage renal insufficiency, occlusions of upper-extremity superficial veins as a result of many previous cannulations and/or essential disease are frequently observed. Such conditions necessitate the usage of a prosthetic graft to create an arterio-venous fistula. Currently, the PTFE prosthesis is the most frequently used type of prosthesis in the construction of vascular access for dialysis. This prosthesis exhibits the best patency rate and the lowest risk of complication.

In the 1980s and 1990s in USA, almost 80% of dialysis fistulas were constructed with prosthesis grafts due to the high risk of early autogenous arterio-venous fistula dysfunction and the 6 weeks required for fistula maturation. Vascular prosthesis fistulas enable earlier cannulation. Prosthesis grafts may also be anastomosed to vessels with greater diameter and greater flow intensity (4). Despite the higher risk of thrombosis, the main reasons for the increased risk of fistula function loss are hemodynamically significant stenosis and infectious complications in prosthesis fistulas as compared to autogenous fistulae.

Published data indicate a 7-8-fold higher risk of fistula infection when a PTFE prosthetic graft is used (3-35% incidence) in comparison to autogenous fistula (2-3% incidence) (5, 6). Moreover, accessible data revealed an almost 10% risk of infectious complications in the first postoperative year after creation of a prosthetic graft fistula (7). For these reasons, current recommendations unambiguously indicate that autogenous arterio-venous fistula represents the best mode of vascular access for dialysis. Nevertheless, in some cases, especially in patients with a history of numerous dialysis fistulas, prosthesis graft usage is necessary for fistula creation as the next step of disease management. The risk of vascular prosthesis infection is higher for dialysis fistula in comparison to femoro-popliteal by-pass preformed with the same prosthetic grafts (8). This is probably related to repetitive fistula cannulation during dialysis sessions.

In our department, the arterio-venous fistula in each patient with septic bleeding was created with prosthetic graft. We did not observe any dialysis fistula infection in patients with autogenous fistulas. These results confirm the benefits of autogenous fistulas and demonstrate the increased risk of complication for vascular prosthesis dialysis fistula. Concurrently, it should be emphasized that the creation and cannulation of a prosthetic graft dialysis fistula must be considered to involve...
Table 2. Septic bleeding due to dialysis fistula infection - patient characteristics and effects of treatment

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Gender</th>
<th>Diabetes</th>
<th>Type of arterio-venous fistula</th>
<th>Number of attempts at vascular access for dialysis</th>
<th>Number of vascular access reconstructive operations</th>
<th>Type of operation</th>
<th>Isolated pathogen</th>
<th>Effect of treatment (30 days after reconstruction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JCz</td>
<td>77</td>
<td>M</td>
<td>yes</td>
<td>arm PTFE loop</td>
<td>3</td>
<td>1</td>
<td>fistula reconstruction: <em>S. aureus</em></td>
<td>excision of infected segment, replaced by autogenous saphenous vein</td>
<td>patent fistula</td>
</tr>
<tr>
<td>KB</td>
<td>61</td>
<td>M</td>
<td>no</td>
<td>brachio-cephalic arm fistula reconstructed with PTFE segment</td>
<td>3</td>
<td>1</td>
<td>fistula reconstruction: <em>S. aureus</em></td>
<td>excision of infected segment, replaced by autogenous saphenous vein</td>
<td>patent fistula</td>
</tr>
<tr>
<td>ZK</td>
<td>72</td>
<td>F</td>
<td>no</td>
<td>arm PTFE loop</td>
<td>4</td>
<td>2</td>
<td>fistula reconstruction: <em>S. aureus</em></td>
<td>excision of infected segment, replaced by autogenous saphenous vein</td>
<td>patent fistula</td>
</tr>
<tr>
<td>MS</td>
<td>62</td>
<td>M</td>
<td>no</td>
<td>brachio-basilic arm fistula reconstructed with PTFE segment</td>
<td>3</td>
<td>1</td>
<td>fistula reconstruction: <em>S. epidermidis</em></td>
<td>patent fistula</td>
<td></td>
</tr>
<tr>
<td>KP</td>
<td>29</td>
<td>F</td>
<td>no</td>
<td>brachio-basilic arm fistula reconstructed with PTFE segment</td>
<td>4</td>
<td>1</td>
<td>fistula reconstruction: <em>S. aureus</em></td>
<td>excision of infected segment, replaced by autogenous saphenous vein</td>
<td>patent fistula</td>
</tr>
<tr>
<td>ZCz</td>
<td>45</td>
<td>M</td>
<td>yes</td>
<td>arm PTFE loop, twice reconstructed with PTFE segment</td>
<td>4</td>
<td>3</td>
<td>excision of infected segment of brachial artery, replaced by autogenous saphenous vein, excision of fistula prostheses</td>
<td><em>S. epidermidis</em></td>
<td>patent brachial artery, no fistula, hematoma drainage, dialysis catheter used as vascular access for dialysis</td>
</tr>
</tbody>
</table>

a higher risk of infection. The results obtained in our department < 3% risk of septic bleeding as a consequence of arterio-venous fistula infection and a lack of this type of complication in the early postoperative period were achieved with a rigorous antiseptic procedure during the creation and reconstruction of vascular access for dialysis, antibiotic prophylaxis, meticulous hemostasis (which decreased the risk of hematoma) and aggressive treatment of superficial infections.

Arterio-venous fistula infections may result from operative wound infection, fistula cannulation, infections of the thrombus present in fistulas and general bacteremia. Recommendations for local prosthetic graft fistula infection treatment include local incision and drainage, partial graft excision, total prosthesis excision combined with artery reconstruction by vein patch-plasty or even brachial artery ligation (4, 5, 9, 10). Typically, vascular by-pass used for infected arterio-venous fistula reconstruction is tunneled extra-anatomically through non-infected tissues. Autogenous saphenous vein is the material most frequently used for reconstruction, but other possible options include a vascular prosthesis or frozen allogenic vein or artery (11). Successful treatment of infected prosthetic dialysis fistula by transposition of regional musculo-
cutaneous or fascio-cutaneous flaps (12), autogenous tissue-engineered vessels (13), and endovascular or hybrid procedures (14) has also been described.

Early arterio-venous fistula infections, occurring in the first postoperative months, are frequently surgical infections and require total prosthesis excision combined with artery reconstruction. It was estimated that infections caused by arterio-venous fistula creation represent approximately 6-15% of all infections due to vascular access for dialysis (6, 15). In our experience, none of the operated patients developed any infection affecting the vascular prosthesis in the early postoperative period. These results may be related to routine antibiotic prophylaxis applied during the creation of prosthesis graft fistulas.

Fistula infections observed in the late postoperative period, after prosthesis incorporation, are usually evoked by fistula cannulation. Those infections are generally limited to cannulated fistula segments. Therefore, different therapeutic options for preserving patent vascular access for dialysis are accessible (16, 17). Previous data indicate that infected fistula segment excision combined with fistula reconstruction did not increase the risk of death compared to total graft excision sacrificing vascular access (4). The risk of complications after partial prosthesis excision was still significant, exceeding 25%. This value is higher than that observed for total prosthesis excision (5%). The most frequent complications after partial prosthesis excision include: local infections not associated with fistula vessel infiltration are observed in approximately 20% of patients. Life-threatening septic bleeding (6%) and bacteremia (2%) are less frequent but still serious clinical problems (18). The risk of late fistula infection recurrence after partial prosthesis excision is rather low (2-8% of patients) but is more frequent in comparison to total prosthesis excision (0%) (5, 15, 18). Partial prosthesis excision combined with fistula reconstruction enables us to preserve patent vascular access for dialysis in a significant proportion of patients (90-95%) (16, 19). We were able to keep functioning dialysis fistulas in 5 of 6 patients, exploiting the vascular access for dialysis immediately after the operation. The rate of fistula patency was 60% after 12 months, exhibiting good long-term results. In the only patient in whom vascular access for dialysis was lost due to septic bleeding, infection affected the vascular prosthesis and the brachial artery. The range of infection necessitated an intra-operative decision to limit the extent of the operation, and we decided to abandon creation of the next vascular anastomosis to diminish the risk of septic bleeding recurrence. We believe that the goals of arterio-venous fistula septic bleeding management include establishing control of bleeding and protection from the recurrence of bleeding. Decisions concerning the attempt to preserve vascular access for dialysis should consider the patient’s clinical condition and local circumstances. Additional vascular anastomosis related to fistula reconstruction increases the risk of complications, especially the recurrence of bleeding. The surgeon should estimate the risk of complications in a particular situation; in certain conditions, the surgeon should refrain from attempts at dialysis fistula reconstruction. Notably, risk factors for prosthetic graft arterio-venous fistula infection include: repeated fistula cannulation, poor personal hygiene, numerous hospitalizations, long period of fistula exploitation, older age, diabetes mellitus (3, 5), low serum albumin concentration (6), arterio-venous fistula located on a lower extremity (especially in obese patients) (3), re-operations (20), immunological deficiency (e.g. HIV infection, immunosupression), previous bacteremia episodes, previous serious infections, and long-term central venous catheter use (3). In our study, risk factors for arterio-venous fistula septic bleeding include: prosthesis graft application, previous operations to achieve vascular access for dialysis, and previous dialysis fistula reconstruction.

Gram-positive cocci such as Staphylococcus aureus (isolated from 50-93% of infected vascular prosthesis dialysis fistulas) (1, 6, 8) and Staphylococcus epidermidis are the pathogens most frequently observed in hemodialyzed patients. Escherichia coli, Serratia marcescens, and Streptococcus pneumonia are less frequently isolated from infected fistulas. Skin infections due to bacteria that colonize the nosopharynx play a significant role in the development of fistula infection, as observed in almost 50% of chronically dialyzed patients (21). For this reason, future investigations should examine Staphylococcus aureus nosopharynx colonization and potential strategies for eventual eradication. In our patients...
Staphylococcus aureus was the most frequently isolated pathogen, provoking dialysis fistula infections and septic bleeding.

CONCLUSIONS

1. Infection of prosthetic graft fistulas may lead to severe complications and loss of vascular access for dialysis.
2. Previous vascular access operations and previous dialysis fistula reconstruction are the strongest risk factors for septic bleeding from infected arterio-venous fistulas.
3. Autogenous saphenous vein is the most suitable material for arterio-venous dialysis fistula reconstruction in patients with infections and septic bleeding. Usage of the saphenous vein to treat septic bleeding brings good results – successful treatment of septic bleeding infections and fistula patency lasting 12 months.

REFERENCES

COMMENTARY

Long-term dialysis treatment can save the lives of many patients diagnosed with chronic renal failure, even in case of complete organ insufficiency. One of the most important conditions for the use of extracorporeal dialysis is the presence of efficient arteriovenous fistulas, which should be performed by skilled surgeons with vascular experience. Considering the many possible complications developing after the above-mentioned procedures, septic hemorrhage from the fistula seems to be most dangerous. It occurs after the use of a prosthesis, in the absence of own vessels. Such a situation is most often observed in case of secondary operations.

The presented study demonstrated an attempt of the most effective solution to the problem. The Authors used an autogenous segment of the saphenous vein in place of the removed middle fragment of the infected PTFE prosthesis.

The Authors of the study demonstrated the superiority of the presented method over the commonly accepted technique consisting in the elimination of the infected fistula, and its replacement by means of a novel approach. The above-mentioned is connected with the introduction of a central catheter, which can be the source of a new infection in patients with reduced immunity during the course of renal failure. The method presented by the Authors seems more beneficial, enabling complete simultaneous reconstruction of the former fistula.

The autogenous saphenous vein is the best graft material in case of infections after vascular reconstructive operations. Additionally, it is also the best material in case of prosthetic arteriovenous fistula reconstructions complicated by infections and hemorrhage.

Considering all risk factors of arteriovenous fistula infections, especially in case of vascular prostheses, iatrogenic factors seem most important, being dependent of the improper use of the fistula. Thus, a practical motion for both physicians and nurses of all dialysis centers in Poland: it is important to maintain proper aseptics, and avoid same place injections.

After becoming acquainted with the above-mentioned study and many years of training, especially by vascular surgeons (including myself), the dialysis center personnel will finally understand the gravity of the problem, considering the use of fistulas.

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