TRANSVENOUS SERIAL XERO-ARTERIOGRAPHY: A NEW NON-INVASIVE ANGIOGRAPHIC METHOD FOR AV-FISTULAS IN HAEMODIALYSIS PATIENTS

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Summary

A new technique — transvenous serial Xero-arteriography (TSXA) — was evaluated in order to avoid the risks of the commonly used angiographic methods in av-fistulas.

The contrast medium is injected intravenously in the contralateral forearm, an average of 5 per cent of the total contrast medium appearing in the arm to be examined. The Xerox-system now allows visualisation of both arteries and fistulated veins. Using a cassette-changer morphologic and functional alterations can be examined.

TSXA is largely free of risk, avoiding arterial access and patient discomfort. TSXA gives reliable information about the real haemodynamic situation of av-fistulas including morphologic and functional alterations. Thus, surgical procedures can be performed more precisely, more carefully and time-saving.

Introduction

Vascular access was and is the weakest element in long-term dialysis treatment. Kjellstrand [1] characterised this fact as the Achilles’ heel of the haemodialysis patient.

Two factors are of importance: the increasing number of patients treated over many years with repeated cannulations and the widespread acceptance for dialysis of aged patients, especially diabetics, and chronically ill patients with severe peripheral vascular disease.

The role of angiographic studies has become more important; firstly for vascular access assessment prior to creating primary vascular access, and secondly in the management of fistula complications. However, careful physical examination may limit the indications for angiography.

The commonly used angiographic methods for assessing av-fistulas required puncture of the brachial artery [2] or catheterisation of the femoral artery [3].
with well recognised risks and patient discomfort.

An important advance was the technique first published by Staple [4]: a pressure cuff was inflated above the arterial blood pressure, then contrast medium was injected into an arterialised vein with retrograde flow. Thus, the venous system was visualised including the anastomosis area and parts of the artery involved. The disadvantages were the altered haemodynamic situation caused by the pressure cuff; stenoses, aneurysms and other abnormalities above the pressure cuff could not be detected and patient inconvenience could not be ignored.

In view of the requirement for a new technique without the above mentioned risks and disadvantages transvenous serial Xero-arteriography was evaluated based on the initial work of Kramann [5].

Method

We use a special Xerox-cassette-changer (manufacturer: Dr-Ing R Gärtnert, D-4000 Düsseldorf, FRG) offering a maximum speed of two exposures per second for eight Xerox-cassettes 24 × 34 cm. The sequence is preprogrammed by means of a punch-card system. In most cases we prefer a 1-1-1-1-2-2-4-4 second sequence.

The fistula-arm is positioned on the Xerox-cassette-changer. Superposition of the blood vessels by the more dense bone structures should be avoided as far as possible. A pressure cuff in this arm is not necessary. Then, 50 to 70 ml Telebrix 380 (manufacturer: BYK-GULDEN, D-7750 Konstanz, FRG), a mixture of Na-ioxitalamate and meglumine-ioxitalamate, are injected intravenously in the contralateral forearm in five to eight seconds. An average of 5 per cent of the contrast medium injected will appear in the arm to be examined. Three to six seconds after the end of injection, the series will be started.

The Xerox-technique now allows visualisation of both arteries and arterialised veins in their real haemodynamic situation including morphologic and functional alterations.

Av-fistulas in 59 patients on chronic haemodialysis were examined.

The patients were divided in two groups: group I with symptoms on physical examination, e.g. aneurysms, stenoses, difficult puncture sites or functional signs such as insufficient outflow volume, increasing venous pressure, steal syndrome and oedematous swelling. In group II patients were examined to check maturation status of av-fistulas or to examine ‘prophylactically’ for alterations in fistula function without evidence of complications. In group II preferably patients were chosen with PTFE prosthetic grafts or micro-fistulas.

Results

In summary, the following angiographic diagnoses were found, only one diagnosis each being mentioned for reasons of clarity:

group I To determine if corrective surgical procedures would be required, 25 stenoses, 9 aneurysms, 7 mainly distal blood flow with oedematous extremity swelling, 4 venous thromboses, 2 arterial abnormalities, and 1 extensive venous collaterals.
group II ‘Prophylactic’ examinations to check fistula status without evidence of a fistula complication in PTFE grafts, 1 venous stenosis, 2 puncture aneurysms and 1 normal. In av-fistulas 3 proximal stenoses in basilic-vein-exteriorisation, 2 maturation failure in normal av-fistula and 2 maturation failure in micro-fistula.

Side-effects were never observed, one patient had minimal extravasation of contrast material.

In 30 patients with av-fistulas still functioning the angiographic findings were not significant and puncture of the av-fistula could be continued. In some cases the cannulation area was changed following the angiographic findings.

Twenty-nine patients underwent surgical intervention. Various operations were performed: ligation of distal, arterial or venous limb in side-to-side anastomoses, thus resolving steal syndromes or swelling of the extremity; new

Figure 1. Side-to-side anastomosis (SSA) between brachial artery (BRA) and basilic vein (BASV) with venous exteriorisation three years ago. Now increasing venous backflow pressure. ST = stenosis; PA = puncture area; AA = accessory artery; AL = arterial loop
anastomoses in various sites with exact preoperative localisation; correction of aneurysms and stenoses, sometimes using PTFE; ligation of extensive venous collaterals; segmental PTFE replacement.

It is interesting that four of the nine patients in group II, who were examined prophylactically, required surgical revision: two patients with proximal stenoses in basilic-vein exteriorisation (Figure 1) and two patients with clinically undetectable stenoses proximal to the venous anastomosis, both having a PTFE prosthetic graft.

Discussion

The problems of vascular access in haemodialysis patients have increased permanently. The necessity for preoperative angiographic studies has increased to determine the optimal way of managing fistula complications.

Ideally, angiography has to reveal morphologic criteria such as size, number and localisation of aneurysms and stenoses, size of anastomoses, suitable accessory venous collaterals and as large an area of the artery as possible. A serial technique would be desirable to evaluate functional alterations such as steal syndromes, maturation failure or reduced blood outflow. The significance of these findings has to be evaluated, e.g. the haemodynamic significance of stenoses.

The commonly used angiographic techniques are unsatisfactory. Direct arterial access requires cannulation of the brachial artery [2] or catheterisation of the femoral artery [3] with the potential risk of vascular damage, haematoma or even thromboses. Venous angiography [4] therefore is a real advance. In spite of the great benefit, contrast-rich visualisation of the anatomical configuration of the av-fistula, there are some disadvantages; 1) only a short area of the artery involved can be examined; 2) the real haemodynamic situation is falsified by the required pressure cuff and 3) patient discomfort may be great in some cases.

Like venous angiography [4] transvenous serial Xero-arteriography is a non-invasive method. The contrast medium is injected intravenously in the contralateral forearm, therefore the arm to be examined remains untouched.

Using a cassette-changer functional alterations can be detected. The real haemodynamic situation can be evaluated. Morphologic changes can be identified and their functional significance estimated. Arteries can be seen in a large extent, thus kinking can be localised exactly and abnormalities in arterial branching delineated. These findings may prevent the choice of unsuited alternative anastomosis sites.

Complications never occurred, no side-effects were observed and patients are willing for repeated examinations.

Superposition of the blood vessels with the more dense bone structures should be avoided as far as possible.

Transvenous serial Xero-arteriography allows the vascular surgeon to operate with an exact plan: direct, limited approach avoiding unnecessary dissection and the opportunity to choose a new vascular access site if necessary.

It must be emphasised that to obtain maximal information the angiographic findings have to be carefully correlated with technical dialysis problems, with previous surgical interventions and with most careful physical examination. Our
patients were examined simultaneously by a radiologist and nephrologist, who in collaboration with two other nephrologists, were responsible for all surgical procedures.

Conclusions

Transvenous serial Xero-arteriography:
1. is a non-invasive angiographic technique avoiding direct arterial access;
2. is largely free of risk capable of being repeated at any time;
3. visualises both arteries and fistulated veins;
4. shows the real haemodynamic situation of av-fistulas, a pressure cuff not being necessary;
5. reliably identifies morphologic and functional alterations by a serial exposure technique;
6. makes surgical planning more precise, more careful and time-saving;
7. can be performed ‘prophylactically’ to check morphology and function of av-fistulas before complications arise.

References

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