Comments

**IPS approach (cases 1-5)**
In principle, every tributary and every vein or sinus draining the CS can be considered a potential venous approach for transvenous occlusion (TVO) of DCSFs. Among all venous routes, the IPS represents anatomically the shortest, technically the less complicated and clinically the safest approach to the cavernous sinus. If posterior drainage is present, the IPS can frequently be passed without problems either using transfemoral approach or, as frequently used in this study, by percutaneous puncture of the internal jugular vein. The IPS approach is usually also successful in cases when the IPS is not angiographically identifiable or indeed thrombosed, and allows cross over navigation in the majority of cases. Some authors emphasize the risk of IPS rupture during catheter manipulation, although there are only seven reported cases leading to subarachnoid, intracerebral or epidural hemorrhage, none of which causing a permanent neurological deficit. One patient in our group showed extravasation during IPS catheterization which remained clinically silent. Because the IPS is located in the extradural space, SAH following IPS-rupture is not very likely to occur. As pointed out already by Shiu et al., perforating the dura mater in this region requires a certain amount of mechanical force. The use of a 0.035” guide wire for recanalization of a thrombosed IPS (“Kuru-Kuru-technique”) can be considered rather aggressive. In such cases the loop technique using small hydrophilic microcatheters and wires (0.010”, 0.012”) is the preferred method, causing less trauma and allowing to successfully manage even so called intractable fistulas.

**SPS approach (case 6)**
As reported by Mounayer, the SPS can be successfully used for catheterization of the CS and should be considered an alternative approach to IPS or SOV approach. The SPS is usually not difficult to catheterize even if not draining the fistula and only faintly opacified. If not accessible from the ipsilateral side because of the acute angle between transverse sinus and SPS, navigation from the contralateral side is another option and is sometimes easier.

**Pterygoid plexus approach**
This approach has been reported by Jahan et al. and can be used like any other femoral route if favorable anatomy is present.

**Middle temporal vein approach**
The middle temporal vein anastomoses with the angular vein and can be involved in the drainage of the fistula. Catheterization of this vein is not difficult if it is enlarged. The acute angle between this vein and the angular vein may cause some difficulties in advancing a microcatheter into the SOV and the CS.
SOV approach, transfemoral (case 7)
The transfemoral SOV approach is a very effective alternative route and in many cases successful. Since its first description by Peterson and Wittingham in 1969, the SOV-approach (usually performed using a guiding catheter in the internal jugular or facial vein) has been reported by various authors. Biondi et al. recently reported the first group of patients treated by this approach only and achieved anatomical cure in six and clinical cure in four patients. This approach is indicated when the SOV is significantly enlarged due to anterior drainage and the IPS cannot be passed. It is usually successful and allows cross over packing of the contralateral CS. It may not be successful if the SOV is very tortuous, stenosed or thrombosed. Extended catheter manipulation may compromise the venous outflow or may result in thrombosis of the SOV leading to clinical deterioration. Aggressive use of guidewires may also cause rupture of the SOV and lead to intraorbital hemorrhage as described by Uflacker. The use of 4F guiding catheter with 0.038 “ inner lumen which can be placed close to the angular vein may facilitate advancement of a microcatheter to the CS. Scott et al. have reported the alternative use of percutaneous puncture of the facial vein to gain access to the CS.

Transophthalmic SOV approach (case 8)
When the IPS and the SOV are not accessible by transfemoral approach, the SOV can be catheterized after upper eye-lid incision using a small needle to introduce a small (e.g. Tracker®-10) microcatheter. This approach has been reported by various authors after initial description by Teng et al. in 1988. It requires a surgeon experienced in microanastomoses and can be performed under sterile conditions in the angiographic suite. It carries similar risks as the transfemoral approach and can be associated with cosmetic problems and blepharoptosis as described by Oishi which however have not been observed by our group.

SOV approach using direct puncture (case 9)
This more aggressive approach was used in one of our patients after all other venous approaches failed and the clinical situation of the patient deteriorated. It carries a higher risk of intraorbital hemorrhage as reported by Goldberg et al. and should be reserved as a last resort for selected cases after all other routes have been attempted. Direct puncture of the CS sinus through the superior orbital fissure as described by Teng has in our opinion a similar limited indication. If performed, the use of high-resolution bi-plane road mapping is mandatory.

Frontal vein (case 10)
This vein is anastomosed with the angular had been used for orbital phlebography in the past and may drain a cavernous sinus AV shunting lesion. Since it can be palpated under the skin of the forehead, direct puncture is technically simple and safe. The percutaneous cannulation of the frontal vein for treatment of a DCSF has been recently reported by Venturi et al. as
transvenous approach for treatment of a DCSF.

**Combined approach (case 6)**
In cases where a bilateral occlusion of the CS is necessary (usually in the case of a rare bilateral AV fistula) and cross over navigation is not possible, various routes may be used either in subsequent sessions or even simultaneously during the same endovascular procedure.

The case in our series could be treated effectively by simultaneous catheterization of the left SPS and right IPS allowing coil packing of both CS in one session.

**Sylvian vein approach (case 11)**
Open surgery can provide unusual access to vascular structures and may facilitate endovascular treatment that is otherwise not feasible. The case described herein was performed in the early period of our experience. Angiographic technique and endovascular armamentarium had been less developed leading to more time consuming and sometimes frustrating sessions. Modern bi-plane angiographic systems with high-resolution road mapping combined with hydrophilic coated and highly flexible wires and improved knowledge of venous anatomy have significantly increased the success rate of transvenous catheterizations. High anatomical and clinical cure rate and decreased number of complications obviate surgical treatment or combined surgical/endovascular techniques today.

In summary, TVO represents a highly effective and safe method for endovascular treatment of DCSFs requiring transarterial embolization only as an adjunct, if at all necessary. While an “intractable” fistula has become the exception, microsurgical approaches should no longer be considered for treatment.

**References:**

8. Goto K: Goto K: The “Kuru-Kuru-Technique” for catheterization of the cavernous sinus., in WFITN-