Brachial plexus palsy


I would like to clarify a few issues.

The first report on the use of the brachialis motor branch as a nerve for transfer belongs to Alexander Lurje,5 who transferred the brachialis motor branch to the radial nerve. In 1999, Dr. Zulmar Accioli de Vasconcellos1 first reported using the brachialis motor nerve to reinnervate motor branches of the median nerve. In 2002, he presented his experience to brachial plexus surgeons at a Club Narakas symposium (Vasconcellos ZAA, Oberlin C, Mira JC. A special neurotization to use in the rare avulsions C7, C8, T1 to wrist and finger flexion [anatomic study and case report]. XIII International Symposium on Brachial Plexus Surgery. Club A. Narakas Meeting, 2002, Paris). The originality of Dr. Accioli de Vasconcellos’ presentation has been recognized by other brachial plexus surgeons.6

Concerning supinator motor branch transfer to the posterior interosseous nerve, our anatomical investigation was published in the Journal of Neurosurgery in 2009,4 followed in the same year by our clinical study.2 We observed that the number of myelinated fibers in the supinator motor branches corresponds to 70% that of the posterior interosseous nerve, which makes the supinator nerve a suitable donor for transfer. In a later report, we confirmed the interest of such surgery in 4 patients. Our experience also was presented to the brachial plexus community at the 2009 Club Narakas meeting, in Luxembourg. Our results were similar to those reported by Dong et al. Contrary to the opinions of these authors, however, we observed that, in chronic cases in which nerve transfer is not indicated, the supinator muscle can indeed be used to improve thumb extension.3

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References
1. Accioli de Vasconcellos ZA: Contribution à l’étude des neu-

Response: We read Dr. Bertelli’s letter and cited references with great interest. We sincerely thank him for reminding us of the preexisting report by Dr. Zulmar Accioli de Vasconcellos,1 which was written in French and was included only in his Ph.D. thesis. Therefore, it was not indexed for the Medline retrieval system and not available to the general public. In 1948, Dr. Alexander Lurje,3 from the Union of Soviet Socialist Republics, used brachialis motor branch to neurotize the radial nerve, which was different from Dr. Yu-Dong Gu’s reported technique.4

Considering supinator motor branch transfer, at the 2009 Club Narakas meeting in Luxembourg, Dr. Bertelli presented his anatomical feasibility paper2 and preliminary clinical findings, and we reported our clinical experience with longer follow-up. In the same year, at the 18th Sunderland Society meeting in Shanghai, the Sunderland community had the opportunity to examine one of our cases 2 years after this transfer. (To our knowledge, this case, finished in 2007, is probably the world’s first case ever done.) Dr. Bertelli’s and our experience convince us it is a useful and reliable method in restoring thumb and finger extension after C7–T1 avulsion. However, we disagree with him regarding his assertion that 6 months should be considered as too late for this nerve transfer as our Case 2 (see Table 1 in the article), which was delayed for 16 months, gained M2 muscle strength in extensor digitorum communis and M1 in extensor pollicis longus.
15 months postoperatively (by the time the manuscript was submitted) and reached M3 in extensor digitorum communis and extensor pollicis longus 21 months after surgery.\(^2\) Compared with Dr. Bertelli’s supinator muscle to extensor pollicis brevis transfer, which only leads to thumb extension, this late case had extension recovery in all 5 fingers. Therefore, we have reason to believe that for chronic cases as late as 2 years, this method may still be useful, although certainly the regeneration process takes longer.

In Dr. Bertelli’s series, he reported that the thumb and finger extensions in all his patients were associated with supination. We have observed an interesting phenomenon in that for the patient in whom both supinator motor branches were divided for transfer, which was exactly what Dr. Bertelli did in all his cases, facilitatory extension could not be achieved. However, in the patients with only one main branch taken for transfer (for preserving forearm supination when the elbow is fully extended or flexed to abolish supination by the biceps brachii), they could extend thumb and fingers more freely (Video 1 and Fig. 1). Whether preserving one supinator motor branch is the reason for the facilitatory extension recovery requires further study.

**Video 1.** Video showing the full extension recovery of the thumb and second–fifth fingers in a patient 15 months after single supinator motor branch transfer to the posterior interosseous nerve. Note that the patient’s finger extension is not associated with forearm supination. The finger flexion was reconstructed by brachialis motor branch transfer to the median nerve at mid-upper arm level without a nerve graft. Click here to view with Windows Media Player. Click here to view with Quicktime.

Finally, we congratulate Dr. Bertelli on his excellent contribution in treating lower plexus lesions in which the final goal is restoration of the pinch function of the hand (apart from what we have achieved, that is, finger flexion by brachialis motor branch transfer to the anterior interosseous nerve or brachialis muscle transfer to the finger flexors and finger extension by supinator motor branch transfer to the posterior interosseous nerve).

**Fig. 1.** Photograph showing the thumb/finger extension in the same patient. The patient naturally extended all fingers when the forearm is kept in the full pronation position (finger extension not initiated by forearm supination).

**References**


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**Supplemental online information:**


This article contains some figures that are displayed in color online but in black and white in the print edition.

**Endoscopic third ventriculostomy**

**To The Editor:** I read with interest the article by Hailong et al.\(^1\) (Hailong F, Guangfu H, Haibin T, et al: Endoscopic third ventriculostomy in the management of communicating hydrocephalus: a preliminary study. Clinical article. *J Neurosurg* 109:923–930, November, 2008). Neuroendoscopy is rapidly evolving. In particular, endoscopic third ventriculostomy (ETV) offers a promising future in the management of hydrocephalus, given the known complications of ventriculoperitoneal shunting. Although variable success rates for ETV have been reported,\(^1,3\) many surgeons consider the procedure the treatment of choice in managing hydrocephalus in children.

Whereas ETV’s success in treating hydrocephalus has been widely reported, opinion on its efficacy in treating communicating hydrocephalus is mixed.\(^2,5\) Many studies have hitherto focused on the role of the procedure...
in the pediatric population, with little known of its role in the adult patient group, and even then many of the studies have been on obstructive hydrocephalus. The work by Hailong and his colleagues represents one of the few examinations into the role of ETV in adult-onset communicating hydrocephalus.

Reasons for the observed success of ETV in communicating hydrocephalus are still largely unknown. It is very likely that all cases of hydrocephalus are actually obstructive at one point within the CSF pathways and that an ostium on the floor of the third ventricle bypasses an obstruction in the subarachnoid space. This has been postulated not only by Ransohoff and Rekate, quoted by Hailong et al., but also by Kehler and Gliemroth, who have proposed an extraventricular intracisternal obstruction to CSF flow as explanation for the success of third ventriculostomy in communicating hydrocephalus.

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Response: Endoscopic third ventriculostomy has become the preferred procedure for obstructive hydrocephalus with outstanding characteristics of minimally invasive manipulations. In the last few years, the role of ETV in communicating hydrocephalus has also been described in several studies. The initial results are encouraging compared with those of shunt placement. However, ETV's utility in the treatment of patients with communicating hydrocephalus has not been conclusively proven.

How ETV works in cases of communicating hydrocephalus is a reflection of the current hot-topic debate on the pathophysiology of communicating hydrocephalus. One school of thought is a modified bulk flow model in which the communicating hydrocephalus is caused by marked thickening of the basal arachnoid and impeded mixing of CSF in the basal cistern. Rekate explored the obstruction sites including not only the aqueduct and outlet foramina of the fourth ventricle but also the basal cisterns. The modified bulk flow model is able to explain the effectiveness of the third ventriculostomy in treating some types of communicating hydrocephalus (traumatic hemorrhage, hypertensive intracerebral hemorrhage, or meningitis). Endoscopic third ventriculostomy may be successful in these cases by creating an internal bypass. However, we think there are still some aspects that do need to be analyzed. For example, it is hard to explain why the fourth ventricle is usually not dilated in patients with communicating hydrocephalus, and we actually find in some patients with communicating hydrocephalus (especially in those with normal-pressure hydrocephalus) that there is no adhesion or membrane thickening from the stoma level to preponote cistern or even medullary cistern. It also seems improbable that communicating hydrocephalus and obstructive hydrocephalus, which behave quite differently with respect to CSF flow (for example, the different flow velocity in aqueduct), have the same causes.

Another hydrodynamic concept of hydrocephalus and the rationale for ETV in communicating hydrocephalus was given by Greitz and colleagues. According to Greitz, communicating hydrocephalus is caused by decreased intracranial compliance that increases the systolic pressure transmission into the brain parenchyma. The systolic force compresses the brain include the intracranial capacitance vessels (that is, the cerebral veins and capillaries). This results in a vicious cycle with narrow capacitance vessels and significantly reduced cerebral blood volume that causes a further decrease in intracranial compliance and a further increase in intracranial pulse pressure. Endoscopic third ventriculostomy may interrupt this vicious cycle and reduce the systolic pressure in the brain by venting the ventricular CSF through the stoma. The patent aqueduct in communicating hydrocephalus is too narrow to vent the ventricular CSF sufficiently. By reducing the pulse pressure, the ETV also reduces the compression of the capacitance vessel, thereby restoring some degree of venous compliance, which in turn further reduces the intracerebral pulse pressure.

Communicating hydrocephalus has remained one of the most controversial topics in neurosurgery. The establishment of accurate diagnosis and the development of selection criteria of ETV candidates are still ill defined. We do not yet have a widely accepted, perfected hydrocephalus theory. The new hydrodynamics theory, which prompts a new explanation for the development of communicating hydrocephalus, still needs further investigation. Future studies will focus on the precise site of CSF absorption and the hydrodynamic alterations before and after ETV. Randomized clinical studies will define the role of ETV in the communicating hydrocephalus therapy.

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High-definition fiber tractography and language

To The Editor: We read with great interest the recent article by Maruyama et al. (Maruyama K, Koga T, Kamada K, et al: Arcuate fasciculus tractography integrated into Gamma Knife surgery. Clinical article. J Neurosurg 111:520–526, September, 2009). The authors are to be particularly commended for pioneering the integration of diffusion tensor–based tractography into Gamma Knife surgery (GKS).5 In this article, the authors reported their results with the retrospective integration of the left arcuate fascicle tractography in 12 right-handed patients with left perisylvian arteriovenous malformations that were treated with GKS. As a conclusion, the authors stated that the administration of a 10-Gy radiation dose was tolerated in the frontal but not in the temporal fibers of the arcuate fascicle.

Fiber tractography is already an established imaging technique with multiple applications in neurosurgery and neuroscience.1 However, diffusion tensor–based tractography has several limitations including poor detailing of fiber tracts, fibers ending in white matter before contacting the cortical mantle, an inability to solve fiber crossings, excessive false continuity, and the inability to follow bundles within fiber tracts.1,3,8-9 High-definition fiber tractography (HDFT) has been recently developed by the application of novel pulse sequences and processing algorithms, such as high-angular resolution diffusion imaging and diffusion spectrum imaging (DSI).1,2 High-definition fiber tractography is characterized by high detailing of fiber tracts, the fact that fibers can be followed to the end point, the ability to follow fibers through crossings, reduced false continuity, and the ability to follow bundles within fiber tracts (Fig. 1 upper). At our institution, we have been using HDFT for precise neuroanatomical studies of the white matter connectivity and for meticulous presurgical planning of selected neurosurgical cases.

The connectivity of language cortical areas (Broca and Wernicke) through the language pathways has been

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one of our primary research focuses. Based on the results of subcortical intraoperative stimulation studies, Duffau et al. described the ventral and dorsal language pathways. The dorsal or phonological pathway corresponds to the arcuate fascicle, while the ventral or semantic pathway corresponds to the inferior occipitofrontal fascicule. Recently, investigators have tried to demonstrate the ventral language pathway using HDFT with partial success. They were not able to show the cortical terminations of the fibers that connect the Broca and Wernicke areas, and they have considered this ventral pathway as equivalent to the so-called extreme capsule. In our surgical planning laboratory, we have been able to demonstrate the cortical terminations of the dorsal and ventral language pathways into the Broca and Wernicke areas by integrating functional MR imaging with HDFT (Fig. I). Importantly, the ventral semantic pathway travels within the inferior occipitofrontal fascicle and crosses the ventral external and extreme capsules, and therefore is not equivalent to the extreme capsule, an error of interpretation imported from the monkey.

The main conclusion of the report by Murayama et al. is that the temporal fibers of the arcuate fascicle are more sensitive to radiation than the frontal fibers because one of their patients developed naming disturbances after treatment. By analyzing the location of the temporal arteriovenous malformation that was treated, the dosimetry map, and the reconstruction of the arcuate fascicle in this patient, we are convinced that the naming deficit was due to radiation-induced damage to the ventral language pathway (inferior occipitofrontal fascicule) and not to the temporal fibers of the arcuate fascicle. Naming errors are typically elicited by intraoperative electrical stimulation of the left inferior occipitofrontal fascicle, and not the arcuate fascicle, and the lesion and dosimetry map are clearly located ventral to the Wernicke area. High-definition fiber tractography allows for accurate white matter studies with great potential to improve presurgical planning in neurosurgery, including GKS. We encourage the authors to continue their pioneering work by applying HDFT into GKS.

**References**


**Response**: Dr. Fernandez-Miranda et al. have provided valuable comments concerning our article by introducing the results of their recent achievements with illustrative figures. They radiologically identified the ventral semantic pathway traveling within the inferior occipitofrontal fascicule and crossing the ventral external and extreme capsules by using HDFT. This technical advancement is so innovative that we have not yet succeeded in separating such fibers by the technique at our institution. Although contemporary progress in diffusion tensor tractography is remarkable as such, it is sometimes difficult to identify the anatomical structures of the brain that are responsible for patients’ language dysfunction arising after a series of treatment, unlike the brain functions that are composed of relatively simple fibers such as the pyramidal tract or the visual pathways. This is because language processing requires the participation of not only the arcuate fasciculus but also a distributed neural system in the dominant hemisphere, as discussed in our original article. Systematic mapping of the brain white matter relating the language function might solve this problem, but it has not yet been clarified sufficiently. According to the study by Duffau et al., intraoperative electrical stimulation of the inferior occipitofrontal fascicule caused semantic paraphasia, and stimulation of the arcuate fasciculus caused phonetic paraphasia. Since semantic paraphasia means naming disturbance, it is possible that Broca aphasia in that occurred in one of our cases might be caused by the radiation injury of the inferior occipitofrontal fascicule. However, to truly prove this fiber to be responsible for radiation-induced naming disturbance, we need to perform further white matter mapping after integration of the visualized tractography into neuronavigation by using a novel technique such as high-angular resolution diffusion imaging. At our institution, we clarified that stimulation of the superficial portion of the white matter in the frontal fibers of the arcuate fasciculus caused semantic paraphasia. Thus, expanded investigation of white matter mapping will be the key to determine the cause of treatment-related neuropathy and, at the same time, to achieve more sophisticated treatment of brain lesions in the future. We hope the integration of white matter tractogra-
phy into treatment planning of stereotactic radiosurgery, as presented by our recent articles, would be followed, verified, and improved further by experts in white matter anatomy collaborating with specialists in stereotactic radiosurgery.

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