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Special Article

A Survey of Vascular Interventional Procedures in Neuroradiology

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Neuroendovascular therapy has grown rapidly in the past few years owing to the addition of new catheters, new embolic agents, and an increasing interest by both neuroradiologists and other clinical specialists. The growth in this area can be seen in the increasing number of presentations in the interventional section at the annual meeting of the American Society of Neuroradiology. From 1987 to 1989, the number of papers in the interventional sessions has nearly doubled. The proliferation of these procedures has been acknowledged by the American Society of Neuroradiology, with the release of the following statement on March 30, 1989:

> The Executive Committee of the American Society of Neuroradiology unanimously supports the imperative that performance of certain elective interventional neuroradiological procedures requires special training and/or experience. Until approved standards for training in interventional neuroradiology have been derived and put into place, it must be the responsibility of each individual practitioner to show that he/she has had appropriate training or experience to include such procedures as a part of his/her practice.

It is unclear, however, how many individuals and centers are performing these procedures, nor is it known what procedures are being performed. Even an appropriate name for this field is debated. A survey was therefore undertaken to assess the current status of this field and to provide at least an initial estimate of the number of procedures and individuals involved in this area.

In February 1988, an anonymous questionnaire was sent to 972 senior members in the American Society of Neuroradiology. Two hundred and eighty-three responded. The survey included questions regarding both experience in and attitudes about neuroradiologic vascular interventional procedures. Specific questions included the number and types of procedures performed, the embolic materials used, and estimates of morbidity and mortality. More subjective responses were also elicited, including the respondents' attitudes about their relationships with referring physicians, whether they considered themselves to be endovascular therapists, and whether they thought the field had experienced growth in the past 5 years. Other questions dealt with the prevalence of competition, attitudes about training, and ideas for a title for the field of neuroradiologic vascular interventional procedures.

Of the 283 respondents, 181 said they had performed at least one procedure in the past 5 years. Of all respondents, the number characterizing themselves as endovascular therapists was 141 (group 1). Of this group, the number of individuals who performed 80 or more procedures in the past 5 years was 39 (group 2). The total number of procedures performed by the 283 respondents in the past 5 years was 13,682. In the subset of those considering themselves to be endovascular therapists (group 1), the total number of procedures was 13,372, or 98% of the total. In the subset of those who performed more than 80 procedures in the past 5 years (group 2) the total was 10,808, or 79% of the total.

The procedures were divided into the following groups: face and neck, brain arteriovenous malformations (AVMs),

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dural AVMs, arteriovenous fistulas, aneurysms, tumors, meningiomas, brachiocephalic angioplasties, intracranial angioplasties, and other. The number of procedures performed in each category was tabulated and the relative percentage of each was calculated. The largest percentage of procedures were in the face and neck and brain AVM categories. The actual percentages for all respondents and for groups 1 and 2 are given in Table 1.

Polyvinyl alcohol (PVA) foam, Gelfoam, detachable balloons, and coils were the most commonly used embolic materials. There were slight differences in the percentages of materials used between groups 1 and 2; most notably, group 2 used more acrylic glue and ethanol (Table 2).

Respondents were questioned regarding the morbidity and mortality of treatment for meningiomas, aneurysms, AVMs, and face and neck procedures. The question was not explicit in dividing the morbidity from the mortality, nor did it define these terms. Therefore, the results obtained apparently contain the combined morbidity and mortality as defined by each individual. An examination of the data from group 2 (>80 procedures in 5 years) reveals that mean complication rates were highest with aneurysms (6.0%) and brain AVMs (6.8%). These two categories also had the largest range of reported complication rates, varying from 0 to 25% for aneurysms, and 0 to 16% for brain AVMs.

In group 1, 40% of the individuals considered themselves to be trained in interventional techniques, while 59% of group 2 stated that they were trained. In both groups, the average training period was less than 1 year, although this varied widely.

Almost 80% of both groups recommended additional training in endovascular therapeutic techniques. Of those recommending additional training in these procedures, two thirds of group 1 recommended one year and the rest recommended two years, while in group 2, the responses were evenly split between one and two years. In both groups, clinical rotations were recommended by the majority of respondents (74% in group 1 and 90% in group 2). Neurosurgery was the clinical rotation most often recommended. However, one third of all respondents in group 2 recommended other rotations as well, including pathology, anesthesia, neurology, ENT, and the animal laboratory.

While only one quarter of all respondents had seen growth in this field in the past 5 years, over three quarters of those individuals performing the most procedures (group 2) had seen growth. Similarly, the respondents in group 2 saw the most competition, with over 25% indicating that there was competition for these procedures from other clinical specialties. However, the relationships between the interventional neuroradiologists and their clinical colleagues appeared to be good. In group 1, only 1–3% of the neuroradiologists characterized the relationship between themselves and specialists

TABLE 1: Types of Interventional Procedures Performed

Procedure Type	Range	Total	Percentage of All Procedures
A. All respondents			
F & N	0–176	2787	23.6
BAVM	0–660	2937	25.0
DAVM	0–100	1353	11.5
AVF	0–100	1152	9.8
Aneurysm	0–200	798	6.8
Tumor	0–77	378	3.2
Meningioma	0–150	1406	12.0
Angioplasty BC	0–172	577	4.8
Angioplasty IC	0–20	65	0.5
Other	0–100	338	2.9
B. Group 1			
F & N	0–176	2666	23.2
BAVM	0–660	2875	25.0
DAVM	0–100	1340	11.7
AVF	0–100	1119	9.7
Aneurysm	0–200	793	6.9
Tumor	0–77	374	3.3
Meningioma	0–150	1364	11.9
Angioplasty BC	0–172	560	4.8
Angioplasty IC	0–20	64	0.6
Other	0–100	330	2.9
C. Group 2			
F & N	5–176	1781	19.8
BAVM	0–660	2668	29.7
DAVM	0–100	1034	11.5
AVF	0–100	907	10.1
Aneurysm	0–200	723	8.0
Tumor	0–77	256	2.8
Meningioma	0–150	925	10.3
Angioplasty BC	0–172	394	4.4
Angioplasty IC	0–20	55	0.6
Other	0–100	247	2.7

Note.—Group 1 = all endovascular therapists, group 2 = those interventionalists with more than 80 procedures in 5 years. Totals in subdivisions differ from overall totals because several respondents did not subdivide the total number of procedures and/or had overall totals that differed from the subdivided totals. Other procedures included trauma, spinal, carotid test occlusions; thrombolysis; vein of Galen fistula occlusion; posterior cerebral artery amytal test; and trigeminal rhizolysis. F & N = face and neck, BAVM = brain arteriovenous malformations, DAVM = dural arteriovenous malformations, AVF = arteriovenous fistulas, BC = brachiocephalic angioplasties, IC = intracranial angioplasties.

TABLE 2: Embolic Material Used*

Embolic Material	Group 1 (total)	Group 1 (%)	Group 2 (total)	Group 2 (%)
PVA	112	80	39	100
Gelfoam	117	84	31	79
Dextran	6	4	5	13
Dura mater	4	3	1	3
Silk	15	11	10	26
Coils	91	65	32	82
Silicone	12	9	5	13
IBCA	40	29	24	62
NBCA	10	7	7	18
EtOH	39	28	21	54
Balloons	99	71	39	100
Other	24	17	13	33

* For each type of agent, the total number of individuals using the material is given first, with the percentage of those in that group using the material given second. Most notably, those in group 2 utilize more acrylic glue and ethanol than do those in group 1.

PVA = polyvinyl alcohol foam, IBCA = isobutyl cyanoacrylate, NBCA = *n*-butyl cyanoacrylate, EtOH = ethanol, other = glycerol, gax, microspheres, angiostat, chemotherapeutic agents, Avitene, collagen, terbal, Sotradecol, platinum wire.

from the fields of neurosurgery, neurology, vascular surgery, plastic surgery, and ENT as abrasive. The majority considered their relationships to be excellent.

Of those in group 1, 78% thought that the best title for their group was Interventional Neuroradiology. Surgical Neuroangiography was second with 8%. Other recommended titles (>1% each) were Neuroendovascular Therapy, Endovascular Neurosurgery, Angiographic Neurosurgery, Surgical Neuroradiology, Neurologic Angiography, Neuroradiology Therapy, and Therapeutic Neuroradiology. The responses of group 2 were only slightly different, with 68% preferring Interventional Neuroradiology and 15% preferring Surgical Neuroangiography.

The results of the survey indicate that a large majority of the individuals who identify themselves as endovascular therapists perform relatively few procedures. Those individuals who performed 80 or more procedures in the past 5 years number only 39. Since the questionnaire was anonymous it is unclear how many institutions were represented. It is expected that from some of the larger centers several individuals may have submitted questionnaires, and that the total number of centers involved in interventional neuroradiology would therefore be less than 39. For the same reason, the total number of procedures performed may also have been inflated. However, only 29% of the total number of surveys were returned, and the survey selected only senior members of the American Society of Neuroradiology. Both these factors could reduce the total number of procedures performed, since junior members of the Society and nonmembers who perform these procedures were not polled. However, it is clear that a significant number of embolizations of face and neck lesions, brain AVMs, dural AVMs, meningiomas, arteriovenous fistulas, and aneurysms are being performed with a variety of embolic material.

There also appears to be potential for growth in this field. A high percentage of the respondents performing the most procedures have also seen growth of their referrals. It is understandable that with the increasing availability and awareness of the endovascular therapeutic approach, more referrals will be generated.

The fact that the majority of individuals in this field recommended additional training to perform these procedures indicates that training standards should be developed and centers with sufficient clinical material should be identified as sites for this training. The recommendation obtained by the survey indicates that 1–2 years of additional training in endovascular therapy is necessary. During this time, clinical rotations are also considered important for complete training. This may have great significance, since competition from other clinical fields was identified. However, the relationship with clinicians, primarily neurosurgeons and neurologists, was satisfactory to excellent in the majority of cases.

In the subset of respondents who reported greater than 80 cases in 5 years (group 2), the morbidity and mortality statistics should be a guide to individuals performing these procedures. However, this is by no means a controlled study and the true morbidity and mortality statistics may differ significantly from those reported, notwithstanding the anonymity of the replies.

The majority of respondents recommended the title of Interventional Neuroradiology for this field. This title identifies the individuals performing these procedures as radiologists, especially neuroradiologists, which may have impact on reimbursement, since these procedures could potentially be classified as surgical or radiologic. Also, referring physicians and hospitals may resist accepting individuals trained in this field as primary care clinicians rather than as consultants. This is perhaps one reason that a high proportion of respondents indicated a need for clinical training.

This survey was by no means complete in its evaluation of the status of endovascular therapy by neuroradiologists. However, it does provide a starting point in identifying the current status of interventional neuroradiology, and in evaluating and developing standards in this field.

The reader's attention is directed to the commentary on this article, which appears on pages 630–632