Editorial

Imaging : tool and material

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The teaching of anatomy has, for some generations, faced two contradictory facts which have been a source of difficulty to students: "the accepted norm" and "encyclopedic knowledge of anatomical variations". Both concepts are important in classical anatomy and imaging anatomy teaching.

The accepted "norm"

The learning of the "typical" form in anatomy is comparable with the Rabelaisian method, which rewards intellectual conformity at the expense of the matter that is taught. The concept of the "norm" sets firm that which is in fact evolving and variable; it fixes in rigid mould the fundamental biological relationship of anatomy: form and function. Indeed the accepted "norm" has become, for didactic convenience, the only one. In its inflexibility it imposes its rules : one studies the body and its organs on right sided halves, and cranial segments of axial, coronal, sagittal and parasagittal sections; the oblique view is "unsuitable". Radiology is equally dogmatic in its teaching from typical images: one still reads carotid angiograms in the same position, the nose to the left, and some journals even impose this orientation.

Anatomy studied for centuries on the cadaver has created modern surgery; in its turn surgery on the living body has lead to a spectacular increase in anatomical questions and answers. Similarly, the effect of, and considerable contribution of imaging in the last 30 years should now be recognised. Interventional

imaging for 20 years has shown, particularly in the central nervous system, how a therapeutic decision based on a single television image is trustworthy in spite of the lack of direct visualization. Such imaging is also an incentive for new anatomical studies and raises new specific questions.

Certainly the performance of surgery requires the learning of anatomy by direct visualization, but apart from reconstructive and transplant surgery, its range of applications is limited. The evolution of operative surgery is towards the absence of direct anatomical visualization. In telesurgery (stereotaxic surgery, endoscopy, percutaneous biliary surgery, and endovascular surgery), one cannot see directly what is being operated upon, as the approach is remote and narrow.

If one form of traditional anatomy has engendered surgery, does telesurgery require a different way of teaching the subject? Could we, and should we, teach another anatomy? However shocking these questions may appear. The answer must be affirmative. Two examples illustrate our capacity to adapt : professional pilots now learn on the ground with a simulator and they fly with instrumental landmarks, without visual control of the ground

over which they fly; our students were not born when Neil Armstrong walked on the moon in July 1969. This generation, better than ours is ready to make decisions with "cathodic eyes", and to understand and trust this "radio anatomy".

If the aim of anatomical knowledge is to help in the patient care, it can remain initially based on the normal cadaver anatomy, if it is enriched by teaching of *in vivo* anatomy. Practically, if one considers, the need in anatomy (from the general practitioners to the specialists), the modern anatomic curriculum should provide: 1/3 of the time spent on morphological (dissection) anatomy, 1/3 on functional (clinical anatomy), 1/3 on *in vivo* anatomy (imaging).

In this époque of 3D reconstruction a student ought to be able to identify among several images that which is 1 cm below, above, medial or lateral to a given one. In the same way he should be able to find among others the orthogonal or oblique projection of a structure presented at a particular angle.

The image has a meaning that only a specific anatomical analysis will reveal. It is an exploratory method like dissection, but perhaps more interactive. The student will have to question the image and deduce what he does not see. Yet by this method the truth of the image is already as real as the truth derived from direct morphological analysis, with the same degree of reliability and with the same limits. The stage of strict radio-anatomical correlation is not needed.

One can thus enrich the traditional anatomy of the "typical" form with anatomical imaging making electronic dissection parallel to the anatomical dissection. One should however, avoid replacing one rigid system (typical form) by another (radio-anatomic correlation) but use the image at this stage as a distinct anatomical tool.

Anatomical variation

The relation between form and function allows many morphological variants compatible with function. The frequent observation of this illustrates the selection which the system undergoes, but usually without immediate practical (clinical) importance. A rare variation becomes significant and interesting if it is re-sited in the flexible system, where it constitutes a stage or an edge allowing one to define the direction of the variability. Variants between these limits reproduce patterns existing in actually living species; some of them, although very different, are adaptative, but have no place in selection in the actual ecosystem. Numerous anatomical arrangements are thus possible and the combinations, though appearing to be infinite, are predictable; the variation can even be described before it is encountered.

So one arrives at a concept of a Darwinian type of anatomical variation in which the intervention of natural selection in the process of evolution takes place in 2 stages: (1) genetic diversification (mutation, recombination or other chance events). It represents the functionally compatible variants (2); variations by selection (it selects the most flexible ones).

Thus the variations which occur are not systematically adaptative and the occurrence itself is, in principle, independent of the ambient condition. In fact, natural selection is effective because it has an almost infinite variability.

In a population of millions of individuals, all different, certain genotypes are particularly advantageous (flexible) in the ecological conditions of the moment. Statistically these have more chances than others of surviving and having progeny. Within the limits of this natural selection operates the selection agent proper, the extrinsic

agent. Evolution is thus neither a chance phenomenon nor a determinist phenomenon, but a double mechanism combining the advantages of the two processes.

In practice the anatomical tradition allows one to grasp these mechanisms and the rules involved.

If one then considers the teaching objectives in the final period of the medical curriculum, which ends with clinical and technical specialisation, the students should be exposed to the anatomical method that is most adapted to his needs, and to the concept of anatomical variability in his chosen area. The population of patients in such a specialisation will be selected by a given group of symptoms, and this increases considerably the chances of the specialist being confronted by an anatomical variation in this specific territory. As seen above, *in vivo* anatomy (radio-anatomy) can contribute to adapting that aspect of anatomy to the needs of the developing medical specialist, and permit illustration of the range of anomalies at the edges where they meet the malformations.

The concept of human anatomy may appear reductive but it fulfills two needs: the doctor in training is bound to treat human beings and the curriculum is too short for time to be given to comparative anatomy. This results in a static impression of anatomy, inflexible, dogmatic, and to a negative impression among some non-anatomist colleagues. In fact, anatomy is only human by choice; it is essentially universal and changing. The variations illustrate both the richness of its past history and its potentials. For example, to study the stars and the planets in our galaxy today without studying their trajectories would be recognized as out dated. If comparative anatomy is the trajectory along which human anatomy travels, teaching of variations should be included following elements of comparative anatomy.

Having such knowledge of anatomy at ones disposal will also help in using the radiological treasure to establish those areas of variation. Images become then an anatomic material freed from the radio-anatomical correlation.

Anatomy and imaging, the same speciality

Without doubt one cannot become an anatomist without training. It is not sufficient to recognise the normal element on CT or MRI sections to master anatomy, nor is the reading anatomical of a radiograph or a constructed image done as if they were a dissection. Anatomists ought to possess one or more methods, whose wilful acquisition is long.

Besides the teaching of anatomy to medical students, post-graduate courses of anatomy with the morphological analysis of the image have become an urgent necessity since wide diffusion of imaging facilities. The lack of accuracy of the average image reader and the multiplication of radio-anatomical contributions illustrates the void left by our discipline. Anatomists must undoubtedly respond to the needs and challenges of this growing population, more by duty than right, following adaptation of their expertise.

These choices and targets are already present; they ought to represent a stimulating factor, able to rapidly establish new anatomical vocations. It is for the French

College of the Professors of Anatomy, which has already created this profile of Anatomico-Radiologist, to choose the rules and the criteria of quality for the future. It is without doubt opportune to seize this unique advantage and to explore the extraordinary teaching means offered by imagery as a tool and as material.

"The true tradition in important matters is not to repeat what others have done, but to grasp the spirit that made these things happen and would engender very different effects at different times".

Paul Valéry