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STEREOLOGY AND MORPHOMETRY AS PARTS OF EDUCATION IN HISTOPATHOLOGY

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ABSTRACT

Stereology and morphometry were included in the histopathology courses of the University of Kuopio during the years 1981-1983. The basic principles were presented during general pathology. The diagnostic decisions based on morphology and morphometry were studied during systemic pathology. This created a new model approach for studying diagnostic decisions in general. Our experience suggests that education in stereology and morphometry can enhance the interpretation of findings in histopathology. In addition biostatistics could be integrated with histopathology, and ways could be opened towards probabilistic argumentation in diagnostic decisionmaking, towards testing human skills of interpretation and towards testing the quality of learning.

INTRODUCTION

Stereology as the science of the three dimensional space can describe the structural organization of tissues in terms of geometry. Geometry is familiar to most university students. Morphometric measurements can describe the microscopic image in quantitative terms, and they can be used to collect data for stereological interpretation. To our knowledge, morphometric methods are not included in any educational courses before the university level. This results in that morphometric methods seem alien and incomprehensible to most students of morphology - and often also their teachers. However, because the mathematics linked with morphometry is basi-

cally simple, morphometry could be included in university courses with morphologic contents. At the Department of Pathology, University of Kuopio, we have taught morphometry to medical students since 1981 (Collan 1984). The start was careful and the value of this approach was not completely understood. We have now realised the educational potential of this approach. Morphometric methods help us in teaching histopathology. After the basics have been mastered the relevance of statistical and probabilistic principles in this connection can be highlighted. Later morphometric methods can also reveal problems of decisionmaking at the diagnostic situation.

STUDY PLAN

Principles of stereology and morphometry and subjects related to them are introduced during our pathology course. The pathology course is in 3 phases: general pathology (one term during the third year of studies), organ pathology I(one term after general pathology), organ pathology II (a shorter course with lectures and demonstrations on gynecologic, skin, otorhinolaryngologic, pediatric and neuropathology). Stereology and morphometry were studied during all three phases. During each phase 2 hours were reserved for lectures and 2 hours for exercises. The present contents of the lectures and exercises are as follows.

General pathology
Lectures:
- geometric probability
- volume fraction estimation
- length density estimation
- surface density estimation
- numerical density estimation

Exercises:
- subjective quantitation of histological parameters
- measurements with point and line grids

Organ pathology I
Lectures:
- principles of disease classifications
- the concept of diagnosis
- variation in diagnostic histopathology
- variation in morphometric studies
- principles of diagnostic decisionmaking

Exercises:
- measurements with point and line grids
- decision patterns

Organ pathology II
Lectures: - scientific basis of diagnostic decisions
- evaluation of prognosis
- basic philosophy related to cause of death
Exercises:
- decisions based on subjective evaluation of histological samples
- decisions based on morphometric analysis of histological samples
- exercises on prognostic decisions
- exercises on cause of death analysis

Traditional stereology and morphometry are covered within the general pathology course. We start with geometrical probability which allows the students to understand why lesions are not seen in one section although they are seen in the other. Volume fraction and its estimation from sections with line grids, point grids or magnetic tablets are treated thereafter. Length density and surface density are explained as concepts and the methods allowing their estimation are explained in principle. The dependence of numerical density on mean caliper diameter of the structures concerned is mentioned as is also the formula allowing estimation of numerical density from two sections with different but known thicknesses. The lectures cover the subject in a simple fashion and numerous examples are given to show how to apply the principles. During exercises the students get various kinds of line and point grids and a couple of micrographs or other pictures. They first try to evaluate subjectively the volume fractions of certain tissue components and then measure these with grids. Statistical aspects are introduced by asking the students to base their estimation on various numbers of points on the tissue structure. Exercises on length density measurements (length of capillaries) and surface density measurements (surface area of the basement membrane) are also carried out. The contents of the lectures will be covered in an article (Collan, Oja and Whimster 1983). A guide will be published on exercises (Collan, Kosma and Whimster 1984).

During organ pathology course I variation linked with subjective estimates and morphometric measurements is handled. How the variation affects diagnostic decisionmaking is explained in detail. Exercises repeat subjective and morphometric estimation and link these with decision patterns leading to "correct" diagnosis.

Organ pathology course II covers the latter subject in a more advanced manner. The studied subjects are intimately related to diagnostic decisions in other fields. How morphometric data can generate prognostic indices is explained in detail. During exercises diagnostic decisions are covered in light of subjective and morphometric data. Also exercises on evaluation of prognosis and cause of death analysis are covered.

DISCUSSION

In general this approach has been received with interest by the students. We cannot say that they have been enthusiastic from the start but many students have got fascinated about the methodology and the thinking it opens into the diagnostic process. Through a model of diagnostic histopathology created by stereology and morphometry it has been possible to approach diagnostic decisionmaking the character of which is usually badly understood by the students.

It is probable that morphometry could also be helpful in other fields. We have realised that stereology and morphometry offer good training material for biostatistics.

What is the correct place for morphometry in the curriculum? Anatomy and histology could also cover morphometry, and so help histopathology to develop diagnostic thinking further.

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