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Case Report
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Stereological Volumetric Analysis of a Case of Bilateral Chronic Subdural Hematoma

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Abstract

Chronic subdural hematoma is a common entity encountered mainly in the elderly population. In this paper, we aimed to perform a stereological analysis of the computed tomography (CT) images of a case with bilateral frontotemporoparietal chronic subdural hematoma. A 77 year old male patient presented with bilateral frontotemporoparietal chronic subdural hematoma. His medical history was significant for anticoagulation. The hematoma and intracranial volumes were measured on the CT images using stereological morph metrical analysis on the case. Cranial CT scanning revealed bilateral frontotemporoparietal chronic subdural hematoma with a width of 2 cm. Stereological volumetrically data was obtained before surgery. The hematoma and total intracranial volume may be important tools to determine on brain volumetric changes and can be estimated using the stereological method before surgery.

Keywords: Bilateral cronic subdural hematoma; Volume estimation; Stereological method; Cranial CT

Introduction

Chronic subdural hematoma (CSDH) is a common neurosurgical entity with an incidence of 13.1 cases per 100000 populations [1]. In 80% of cases, patients are older than 40 years of age. Blood accumulates within the layers of the dura mater over a period of days to weeks. Trauma is probably the most important risk factor for the development of CSDHs, with two thirds of CDSH patients having some type of minor trauma in their history. In addition, traumatic or iatrogenic communication of the subarachnoid space with the subdural space is thought to play a role in the pathogenesis. Additional risk factors include dehydration, chronic alcoholism, and coagulopathies. Clinical presentation of CSDH may vary. Refractory headache and sensor motor and neuropsychiatric changes such as amnestic deficits or lack of concentration are common symptoms. Diagnosis can be established with computed tomography (CT) in the majority of the cases. Bilateral occurrence is noted in up to 25% [1]. The evaluation of SDHs and intracranial volume by using stereological analysis is emphasized in the recent studies. In the present case we evaluated a case with CSDH and total intracranial volumes (TICV) on CT scan using stereological morph metrical analysis.

Case Presentation

A 77 year old male patient was admitted with bilateral frontotemporoparietal CSDH. He had presented with headache, confusion, urinary incontinence and weakness in all four extremities for the last two weeks. His past history was significant for anticoagulant use due to pulmonary embolism. Following correction of his International Normalized Ratio (INR) and Prothrombin Time (PT), he was operated on using the bilateral burr-hole drainage technique. Estimates of hematoma volume were obtained according to the Cavalieri principle, retrospectively [2]. The object under study is intercepted by a series of parallel planes separated by a distance t, and the corresponding cross-sectional areas are estimated by point counting. To remove the influence of line thickness, a test point is consistently defined as the upper right corner of intersection between outer test-lines in the point-counting grid. Point counts are converted into section areas by multiplying the total number of counted points, ∑P, by the area per test point a (p). The volume of brain compartments is finally estimated by multiplying the distance between sections, t, by the area per point and the total number of counted points as follows: [1] $V_{ref}=t\times a(p)\times\sum P$ Volume fraction. Volume fraction ranges from 0 to 1 and is often expressed as a percentage [3-5]. The volume fraction of a phase can be

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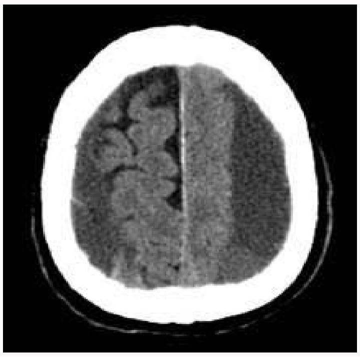

Figure 1: CSDH areas have been shown in axial CT view of the 77 year-old male patient.

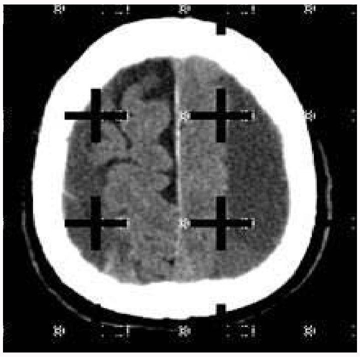

Figure 2: Stereological measurement of the TICV and CSDH areas have been shown in axial CT view of the 77 year-old male patient.

estimated by means of the Cavalieri principle on radiological images using the point-counting approach [6]. The volume fraction formula combined with the Cavalieri principle. t is the sectioning interval for n consecutive sections, SU the scale unit of the printed film, d the distance between the test points of the grid, SL is the measured length of the scale on the printed film, ∑PX indicates the number of points hitting the X phase and ∑PY the number of points hitting the reference space Y. Since the same images are used for the volume fraction estimation of any subject, the number of points counted (i.e. ∑P) is the only value of the volume fraction formula which changes. Thus, the formula can be simplified [7-11]. Usually, the phase within the reference space is smaller in size [3,4]. The CT images of a section series at 5 mm thickness without interval were used to estimate CSDHs and intracranial volumes. These images were printed on films in frames measuring 6 cm × 8 cm. The CT images were used to estimate volume fractions of CSDHs within the total intracranial volume using a transparent square grid system. A square grid test system with d=0.3 cm, i.e., 0.12 cm 2 representing area per point was used to estimate the sectioned surface area of the slices of axial planes. The representative area per point in the grid was corrected with the reduction ratio of the printed sections. The films were placed, in turn, on a negatoscope and the distinction of each specimen was done with guidance of the scan gram of the section series. The transparent square grid system was uniformly superimposed randomly covering the entire image frame. All mathematical calculations were based on Cavalier principle. All results of volumetric measurements were recorded in a Microsoft excel file. For each case area of total intracranial volume (TIV) and SDH were determined bilaterally and recorded as a radio logically (Figure 1 and 2). Ethical improvement

Table 1: Stereological measurement of the TICV and CSDH areas of the patient.

Volumetrical data		
TICV	Right CSDH	Left CSDH
989.2749 cm^3	82.71605 cm^3	175.3086 cm^3

was taken the university. Cranial CT scanning revealed bilateral frontotemporoparietal chronic subdural hematoma with a width of 2 cm. The stereological volumetrically data of TICV and left and CSDH has been given on Table 1.

Discussion

The different software such as OSIRIS, Dicom Works and Image J, etc., have recently been used for plan metric measurement [12]. Planimetry achieves more accurate results while the point-counting approach takes less time. The point-counting method can be applied to any sets of printed CT and MR images and it allows one to perform retrospective and prospective studies without the need for the MR and CT machines and their PC accessories [11,13]. The volume of an organ or organ component and the variable component in a structure, the volume fraction of these components relative to each other or to whole structure are frequently used and include the important parameters in morph metric studies [3,4,7]. Using two-dimensional images in stereological methods provides quantitative data on three-dimensional structures. There are no study on ICV and hematoma volume fraction that applies the unbiased techniques of stereological methods on ordinary CT scans, although several studies have estimated the volume fraction of microscopic structures [14,15]. Sectional imaging techniques have provided an opportunity for volumetric data on the intracranial cavity. Thus, CT and MR imaging of the brain and other structures may be measured in a reliable way. Magnetic resonance imaging offers optimal soft tissue contrast resolution and multiplanar capability without the use of ionizing radiation. For the evaluation in EDH/SDH patients, several researchers have reported inconsistent data due to lack of precise criteria [4]. The volume of biological architecture may be estimated by combining the radiological imaging techniques with the stereological volume analysis as defined in previous studies [9,10]. The human brain does vary widely in size. Up to date, researchers have displayed several factors contributing to this variation. Factors dependent on brain growth, such as gender and physical size, are thought to effect the maximal size of an individual's brain [16,17]. The volume fraction of a component within a reference volume is a simple and very widely used parameter in biomedical science [14,15,18,19]. We conclude that the rates of brain atrophy, especially the regional rates of volume enlargement measured on structural CT images are useful for the detection of hematoma location and predicting its regional complications. The present case report evaluates anatomic features of CSDH and relates adjacent structures and outcomes with the use of the surgical treatment approach for the patient with CSDH in the cranium. Before the operation, although the surgeon had sufficient diagnostic information radio graphically, it was decided to predict the position of adjacent anatomic structures more precisely. The stereo logic method provides quantitative data via the Cavalier principle in biologic materials like brain. The method is also simple, easy, fast, and accurate while evaluating hematoma's volume. Before surgery, volume measurement of the hematomas may also benefit in terms of surgery technique, surgeon time, operation materials choice, patient safety, etc. However, further studies are needed with a larger patient population in order to confirm these results.

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