Signs of routine CT and MRI in differential diagnostics of venous and arterial stroke's genesis

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Aims and objectives

Cryptogenic character of stroke is noted in cases 22-30% (1). Probably like cryptogenic often called venous stroke which is considered "relatively unknown cerebrovascular disease" occurring on different data from 0 to 5% of all strokes (2, 3, 4) and according to the American Heart Association/American Stroke Association recommendations in 0.5-1% of all strokes. In 3% of cases it is the cause of cerebral venous thrombosis which in the localization of deep venous structures (internal veins, vein of Galen, straight sinus) leads to venous ischemia of the thalamus and basal ganglia in 16% of cases (5).

Closest to identify early morphological signs of a stroke are non-contrast native (routine) CT of head with a sensitivity in the acute phase 37-60% (6, 7) and after 2-3 days to 83-92 % [8, 9] which in combination with clinical examination recognized by the International (10) and Russian (11) standards for the diagnosis of stroke as well as diffusion-weighted imaging using MRI especially in acute phase of ischemic brain lesions (12). Introduction to diagnostic research protocol in first hours after stroke's onset the perfusion CT (PCT) or perfusion-weighted MRI significantly increases the sensitivity to 96 % and specificity of 98% (13, 14).

Venous infarction unlike arterial is distinguishing by blood cognition and hyperemia, diapedetic bleeding which is not accompanied by pathological changes in any arteries territories. There is ischemic infarction only as secondary lesion and may be named like venous ischemia (15). Non-hemorrhagic venous stroke is yet more "unknown cerebrovascular disease" in neurological and radiological practice and publications as evidenced by increased incidence of diagnosis of this disease from 0.3% to 2% in a short period of 3 months at a certain wariness diagnostic department (16).

Unlike the standard examination of patients with stroke's suspicion is limited only native CT (10, 11) and only some hospitals used conventional MRI as urgent diagnostic method without contrast angiography and perfusion techniques the routine venous stroke signs are remaining actually. And the aim of this work was definition of localization, size and other characters of typical venous stroke foci compared ischemic stroke via used MDCT and MRI diagnostic criteria on the basis of verified cases with contrasting techniques.
Methods and materials

Random sampling of patients with a confirmed diagnosis of venous stroke selected for the period from 2008 to 2012 years. The sample consisted of two parts. The first part included 36 patients diagnosed with Code I63.6 Cerebral infarction due to cerebral venous thrombosis, nonpyogenic (ICD-10 (17)). Dates of their examination results from different hospitals were evaluated retrospectively for an overall picture of both clinical and radiological features of this rare disease. According to the results of the retrospective study, the optimum range of clinical and radiological examination methods was selected to perform a second prospective part. In the prospective part included 33 patients with non-haemorrhagic venous stroke (VI) verified caused by cerebral venous thrombosis (CVT) and the comparison group (33 patients) with arterial ischemic stroke (IS) selected at the Regional vascular treatment center and registered in the database Russian register of stroke. All study participants or their legal representatives gave informed agreement. The study was approved by the local ethics committee.

Verification of the diagnosis performed neuroimaging methods in all cases and at post-mortem study in cases of death. Neuroimaging included native non-contrast MDCT, PCT (cerebral blood flow - CBF, cerebral blood volume - CBV, mean transit time - MTT), MDCTA intracranial vessels for 40 minutes after door used 64-slices CT scanner, MRI (axial T1WI, T2WI, FLAIR, DWI + ADC), 3D-ToF MRA of intracranial vessels in the first 24 hours of the disease by MR scanner 1.5T.

On diagnostic images were identified focus area (cm$^2$), its contours and localization. And then we compared between different CT and MRI methodology to match the correlation values and the area affected.

In the statistical analysis of quantitative material determined minimum and maximum values, calculated the average mean values, standard deviation, confidence interval. By using the Shapiro-Wilk test was assessed compliance of the actual distribution of quantitative indicators normal. To assess the equality of variances in the two groups was used the criterion of Leuven. When under the actual normal distribution and equal variances in compared 2 groups used a parametric Student’s t-test. The average criteria were compared with using the LSD. In case of noncompliance the actual distribution of the normal used nonparametric Kruskal-Wallis test. When qualitative analysis contingency tables were constructed and used Pearson’s criterion. In determining the relationship between quantitative indicators used Spearman correlation analysis. The null hypothesis was rejected at p<0.05.
Results

Cord sign on routine CT detected at VI in 54.5 % of cases (fig.1a), with IS in 30.3%. On T2WI MR-images hyperintensive signal sign in thrombosed dural sinuses like distal and proximal parts these vessels was also detected.

Localization of lesions was determined by VI "vascularity" principle like IS. Just in the case of VI "vascularity" was not in flow but out flow or drainage (5, 18). There were three groups. The group 1 with the localization of lesions in the frontal and temporo-parietal areas with occlusion of anterior and middle thirds of the superior sagittal sinus included 5 patients (7.2%). The group 2 with localization in the parietal and occipital lobes, cerebellum and brainstem with occlusion of the posterior third of superior sagittal sinus, lateral sinuses and internal jugular veins included 40 patients (58%). The group 3 with the localization of lesions in corpus callosum and subcortical structures with occlusion of inferior sagittal and straight sinuses and internal veins included 24 patients (34.8%). The suspicion for VI can be considered close proximity focus (fig.1b) to the affected sinus (found in 87%).

VI did not fit into geometrically regular shape territorial "vascularity" like IS (19). In 62 of 69 cases (90%) form of VI foci was irregular and contours were not sharp. Only in 7 cases of VI foci contours marked relatively sharp. Foci contours in IS cases on routine CT images and T2WI, FLAIR MR-images were sharp enough.

No statistically significant differences between the VI and IS were detected in relation to the area of focus stroke on PCT (CBV mapping, fig.2a) and on different sequences MRI (T2WI, fig.2b; FLAIR, fig.3a; DWI, fig.3b; ADC mapping). Size of VI foci ranged from 1.82 cm² to 16.48 cm² (average 6.56±3.94) and IS - 1.5 cm² to 32.57 cm² (9.53±9.44). Considered the most accurate predictive criterion for the final infarct size (18) lesion area (cm²) on CBV mapping (PCT) is strong correlated with lesion area on DWI (r=0.95) and apparent diffusion coefficient mapping (r=0.83), with area on T2WI (r=0.86). And also the lesion area on CBV mapping correlated with the affected area on FLAIR (r=0.56). Area of the lesion measured on T2WI strong correlated with an area of focus on DWI (r=0.87) and ADC mapping area (r=0.73) and with area on FLAIR images (r=0.85). The very strong correlation was found between the indices DWI and ADC mapping area (r=0.9) of course. The medium correlation was detected between area on DWI and area on FLAIR images (r=0.62). The weak correlations were detected between area on FLAIR and area on CBV mapping (r=0.56) and also with area on ADC mapping (r=0.43).
Fig. 1: The cerebral venous sinus thrombosis and venous stroke on axial CT-images: a) the thrombus in right transversal dural sinus looks like cord sign (arrow); b) the venous stroke's focus in right occipital lobe have an irregular form (into circle).

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Fig. 2: The focus of venous stroke in right occipital lobe (into circle) is congruent and similar for visual comparison on: a) CBV mapping with 30% increasing in hyperemia of stasis zone; b) T2WI with hyperintensive signal.

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Fig. 3: The most complete similarity of shapes, contours and size of focus venous stroke (into circle) were observed when comparing MR-images: a) FLAIR; b) DWI.

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Conclusion

The practice of using MDCT and MRI without contrast techniques which recommended by Russian national and international standards in the diagnostics of stroke may allow non-haemorrhagic suspected venous character stroke based on some of the most reliable symptoms. These can include hyperdensity cord or vein sign on routine CT, "typical" localization in the parietal-occipital region and cerebellum when the superior sagittal or transverse and sigmoid dural sinuses thrombosed, as well as the corpus callosum and thalami foci take placed when inferior sagittal and straight dural sinuses, internal veins thrombosed. Localization venous insult does not fit within any "arterial vascularity territories". Venous insult's foci have often irregularly shape and non-sharp contours. Location close to thrombosed sinus is also a specific symptom. Important has a strong correlation between area of lesion on T2WI and area on DWI (MRI) and with area on CBV mapping (PCT) which recognized are the final infarct size markers. This indicates the high importance of routine T2WI which is considered high sensitive despite low specific.
References

