Correlation between morphological integrity of brain structures in and the length of a donor's terminal period

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INTRODUCTION

Histological evaluation of brain areas is a significant part of various biomedical studies. Proper donor selection and brain autopsy sequence are important factors for procurement of high quality brain specimens. Hydration and ischemia are major known contributing mechanisms of brain tissue damage.

MATERIALS AND METHODS

This study was conducted at the Central Moscow Forensic Laboratory (Russia), where clinical and criminal death cases are autopsied for determination of the cause of death. Three hundred eighty six (386) cases with the cause of death being an acute hemorrhage were selected for this study. Post-mortem interval prior to specimen collection was identical for all cases (4 – 5 hours), while all cases were distributed into two groups:

(1) short terminal period (few minutes)
(2) prolonged terminal period (longer than 24 hours)

Table 1. Biospecimen collection protocol

Data Elements	Source Data
Biospecimen type	Solid tissue
Anatomical site	Various brain areas
Disease status of patients	Unknown, relatively healthy donors
Vital state of patients	Postmortem
Cause of death	Acute hemorrhage
Pathology diagnosis	Histomorphological and molecular evaluation, brain areas
Collection mechanism	Autopsy
Type of stabilization	none

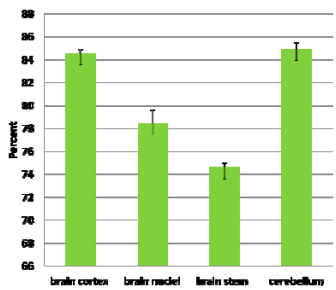
Brain tissue samples (200mg) were collected from various brain structures including brain cortex, hypothalamus, cerebellum, sustancia negra, brain pons, brain stem and cerebellum. Exact wet weight of each specimen, as a measurement of interstitial fluid and hydration, was determined prior to placement into the laboratory oven. The brain tissue samples were dried at 100°C for 5 hours, and weighted again for determination of the dry weight.

RESULTS AND CONCLUSIONS

It has been previously reported that distribution of interstitial fluid and associated hydration in brain specimens collected post-mortem varies in different brain areas. This data were confirmed in our experiments as well.

Table 2. Distribution of interstitial fluid in various brain areas

Brain Area	Interstitial fluid distribution (% ± SD)
Brain Cortex	84.5 ± 0.4
Brain nuclei	78.4 ± 1.2
Brain stem	74.6 ± 0.4
Cerebellum	84.9 ± 0.6

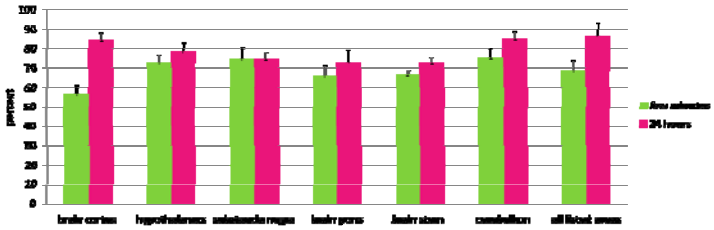


RESULTS AND CONCLUSIONS

We report here that interstitial fluid distribution and hydration in certain brain structures correlates with the length of a brain donor's terminal period.

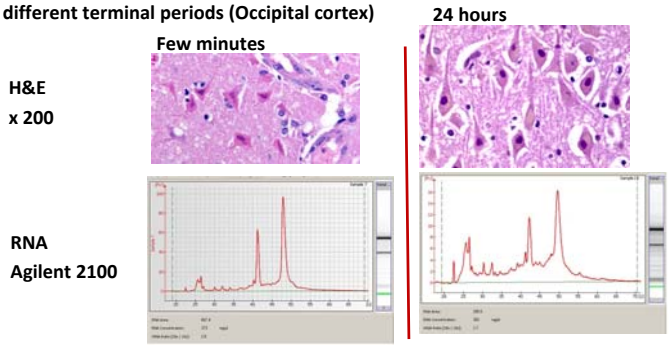
Table 3. Hydration of various brain areas depending on terminal period duration

Brain Area	Hydration (% ± SD)		Increase in hydration (%)
	Terminal period few minutes	Terminal period 24 hours	
Brain cortex	**56.7 ± 4.6**	**84.5 ± 3.6**	**49***
Hypothalamus	72.6 ± 4.2	78.4 ± 4.6	8
Sustancia negra	74.4 ± 6	74.7 ± 3.2	0
Brain pons	65.9 ± 5.1	73.1 ±6.2	11
Brain stem	66.8 ± 1.9	72.7 ±2.7	9
Cerebellum	**75.4 ±4.6**	**85.4 ±3.6**	**13***
All listed areas	**68.6 ± 5.2**	**86.8 ± 6.3**	**27**



Hydration has been significantly increased (*) in the group with prolonged terminal period in brain cortex (49%) and cerebellum (13.3%). Moderate increase of hydration was observed in hypothalamus, brain pons and brain stem (8 – 11%), although not significant. No change was found between substantia nigra hydration in two groups.

Picture 1. Examples of histomorphological and molecular changes in tissues with different terminal periods (Occipital cortex)



Short terminal period: slight pericellular and perivascular edema. Ischemia of some neurons; good RNA quality.

Prolonged terminal period: significant pericellular and perivascular edema. Ischemia of majority neurons, moderate glial changes; significant RNA degradation.

These findings indicate that a prolonged terminal period increases brain hydration and causes morphological damage regardless of postmortem interval, and that these changes are dependent on the brain area. To avoid an accumulated damage, brain cortex and cerebellum should be harvested as a priority tissue while performing a brain tissue acquisition.

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