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Sistema Socio Sanitario Regione Lombardia

The use of ultrasound in patients with Disorders of Consciousness: preliminary results

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Background and aim

Disorders of Consciousness (DoC) after acquired brain injuries can last up to **many years** [1]

Improving **diagnostic** and **prognostic** accuracy is pivotal to better orient the **pathways of care** and tailoring **rehabilitative interventions** [1,2,3]

The **instrumental tools** used so far (e.g., magnetic resonance imaging) to ameliorate diagnosis and prognosis are **costly** and often require the **transfer of the patient** in specialized centres

The **ultrasound techniques** (US) allow the acquisition of **morphological** and **blood flow**-related information useful for DoC diagnosis and prognosis [4,5,6]

The aim of the present study is to present preliminary results on **diagnostic** value of **US measures** on a cohort of post-acute and chronic **DoC patients**

Materials and methods

Participants

n= 74 DoC patients

	Chronic (n=41)	*Post-acute* (n=33)	p value
Age	56.53±15.09	50.09±18.58	.10
Education	10.68±3.52	11.22±4.33	.56
Male	46.34%	72.72%	.02
Female	53.66%	27.28%	
TBI	22.23%	36.84%	.24
Non-TBI	77.77%	63.16%	
UWS	36.84%	28.57%	.48
MCS	63.16%	71.43%	

Tab 1. Main features of the enrolled DoC patients (either post-acute or chronic). Age and education are given as mean±SD, all the other variables are expressed as percentages. A significant difference in sex distribution was found between post-acute and chronic patients.

Procedure

Fig 1. DoC patients were divided into chronic (≥1 year from the acute event) and post-acute group (<1 year from the acute event). After the screening (**T0**), each patient has been administered with the **Coma Recovery Scale-revised** (CRS-r) to evaluate the **level of consciousness** and **US protocol** recording the **cerebral blood flow** variables from the following cerebral arteries, bilaterally: Anterior (ACA), Middle (M1), and Posterior (P1). Moreover, the **morphological** variables were recorded for parenchyma, midbrain, and III ventricle. The same examinations will be repeated at **T1** (i.e., 1 year from the acute event for post-acute patients, 6 months from T0 for chronic patients). Note: ABI= Acquired Brain Injury.

Statistical Analyses

Cerebral blood flow-related dependent variables (T0): peak systolic velocity (PSV), end-diastolic velocity (EDV), mean velocity (MV), Pulsatility Index (PI), Resistive Index (RI), Heart Rate frequency (HR)

Morphology-related dependent variables (T0): echogenitcity and omogeneity for parenchima; simmetry, omogeneity, and dimension for midbrain; simmetry, pulsality, and dimension for III ventricle

Outliers were removed for each continous dependent variable of interest, separately by considering ±2 SD from the mean; Alpha level was set at $p<.05$ for all the analyses and Bonferroni's correction was applied whenever necessary

- **Difference dpending on the level of consciousness**: independent sample t-test was used for continous variables and Chi-square test for categorical variables, considering the group (UWS, MCS) as independent variable. Spearman's correlation was adopted between the US continous variables and the CRS-r total score at T0
- **Difference between chronic and post-acute**: independent sample t-test was used for US continous variables at T0; Chi-square test for categorical variables at T0

Results

UWS vs MCS

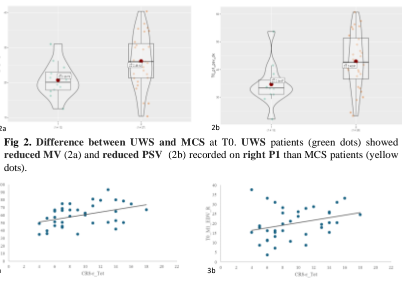

Fig 2. Difference between UWS and MCS at T0. **UWS** patients (green dots) showed **reduced MV** (2a) and **reduced PSV** (2b) recorded on **right P1** than MCS patients (yellow dots).

Fig 3. Correlation between cerebral blood-flow variables and CRS-r total score. Higher CRS-r scores were associated with an increase of PSV (3a), EDV (3b), and MV (3c) recorded on the right M1 on 37 DoC patients

Chronic vs post-acute

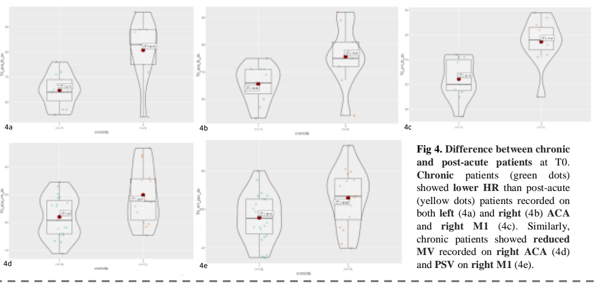

Fig 4. Difference between chronic and post-acute patients at T0. **Chronic** patients (green dots) showed **lower HR** than post-acute (yellow dots) patients recorded on both **left** (4a) and **right** (4b) **ACA** and **right M1** (4c). Similarly, chronic patients showed **reduced MV** recorded on **right ACA** (4d) and **PSV** on **right M1** (4e).

Conclusion

Despite being preliminary, these results are promising for encouraging the adoption of US techniques in the management of DoC patients since the low associated costs with respect to other instrumental tools and their direct applicability at the patients' bedside. More data are needed to confirm the patterns observed in these cohort of patients and the prognostic value of the US techniques

Discussion

- The **differences** found between chronic and post-acute DoC patients emerged only for some blood-flow-related variables and, mainly, for the HR detected from ACA and M1. This result is possibly related to **autonomic dysfunctions** characterizing severely brain-injured patients in **post-acute** phase than chronic one [7]
- The differences found between UWS and MCS are partly in line with the existing literature. A reduction of PSV and MV from P1 in **UWS** was possibly due to a **higher cerebrovascular resistance** [5] characterizing this diagnostic cohort, and it might be interpreted as a **more impaired cerebral autoregulation** [8] than what was observed in MCS. Despite from a different artery (i.e., M1), this result was in line with the **correlations** found between the level of consciousness assessed through the **CRS-r** and the **PSV**, **EDV**, and **MV** values

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