

# Maps of ventricular activation time differences in children with end-stage renal failure – a pilot study

## INTRODUCTION

Chronic kidney disease (CKD) leads to multi-organ disorders, out of which cardiovascular complications may be perceived as the most significant clinical problem, as the main cause of mortality in patients with CKD, both children and adult. It is estimated that the risk of fatal outcome in children with end-stage renal disease ESRD is, so far, 10 times higher than that in the general population of children.

The pathogenesis of cardiovascular complications in CKD is complex and multifactorial, the consequences of which include vascular changes, degeneration of cardiomyocytes, hypertrophy of the left heart ventricle, arrhythmia and disturbances in the conduction system of the heart. The conduction system of the heart is responsible for a normal spread of electric impulse, starting from the atrioventricular junction through the His bundle and its right and left branch. Conduction changes in His bundle branches lead to depolarization delays in a corresponding heart ventricle and disorders in hemodynamic synchrony. The main function of the heart is a proper stroke volume determined by ejection volume and heart rate. Disturbances in systolic and diastolic functions of the heart, in particular of its left ventricle, are observed in all CKD stages and, also, after kidney transplantation.

## AIM

The aim of the study was a pilot analysis of disturbances in the heart ventricular conduction system, using a map of ventricular activation time (VAT) differences in children on peritoneal dialysis (PD).

## MATERIAL AND METODS

The study involved 10 ESRD children (4M/6F; the mean age: 13.6 ± 2.31 years) on peritoneal dialysis (PD) - group I. The control group (group II) consisted of 26 healthy children (12M, 14F) in similar age and presenting no renal or cardiac clinical symptoms, as well as showing normal arterial blood pressure values and no abnormalities in ECG, ECHO or BSPM. The time period of renal replacement therapy by automated peritoneal dialysis (APD) varied from 6 months to 1.7 years (the mean value: 1.17 ± 0.33). The Kt/V index was 2.11 ± 0.05. Standard prescription of APD (HomeChoice Pro; Baxter Healthcare) included dwell changes of 9-12 hours, with 800-1000 ml/m<sup>2</sup> BSA of 1.36% glucose PD4 (Baxter) per dwell/per fill volume/. Two (2) patients had a routine APD prescription. Three (3) of the patients had PD with Physioneal on alternate days. Five (5) of the patients had APD cycles with 1.36% PD at night and, additionally, up to 2 CAPD changes during daytime with 2.27% glucose. Glucose concentrations were dependent on fluid amounts to be removed to maintain a clinically euolemic state. Three (3) children with APD were anuric. Other (7) patients with residual renal function had urine output of 721 ± 133 ml/day.

The administered pharmacotherapy included: hypotensive agents, erythropoietin, analogues of vitamin D, vitamin C, folic acid and iron supplements.

### Body Surface Potential Mapping (BSPM)

Body surface maps were plotted with an 87-lead FUKUDA DENSHI HPM-7100 system. The electrodes are fixed at determined locations on flexible, disposable tapes, on the anterior and posterior part of patient's thorax, with the patient in recumbent position (Fig. 1). The tips of the tapes are connected to the recorder's wires.

## RESULTS

### Group I – control group

In the heart of a healthy child, activation begins in the atrioventricular node, then passes through His bundle to its both bundles of the right and left branch and, further on, through Purkinje fibres, up to the working muscles of the appropriate ventricles.

While evaluating the isochrone maps of children in Group I, it was found that activation used to begin at approximately 15 ms in the subendocardial layer of the left lower surface of the ventricular septal defect and in a part of the free left ventricle wall (Fig 2).

### Group II – peritoneal dialysed children

In the patients, treated by peritoneal dialysis, the distribution of isolines on VAT maps is partially different in comparison to the control group. It is compliant with the map pattern of the early anterior bundle block of the left His bundle branch.

Similarly as in the control group, it is the subendocardial layer of the left lower surface of the ventricular septal defect, which is first activated (Fig.3).

Fig. 4 presents a map of statistically significant differences (with consideration of the confidence interval), calculated from VAT values in particular monitoring sites, indicated on the averaged isochrone maps for the studied groups. Maps a and b illustrate the distribution of isolines: map a – on the plane, map b – in the space (in order to more precisely localise the changes).

## STUDY LIMITATION

The main limitation of the present study was the limited number of patients. However, it is just a pilot study, with plans of continuation. Besides, one should keep in mind that the population of children with terminal stage of renal failure is relatively small. Moreover, our study could exclusively include patients of one clinics, both for legal and logistic reasons.

## CONCLUSIONS:

VAT maps (isochrone maps) reflect precisely a trajectory of activation in both heart ventricles.

Differences in VAT values enable to identify early disturbances in the left His bundle branch, despite normal 12-lead ECG in young patients with ESRD.

Further studies on larger groups of children with ESRD, treated by peritoneal dialysis, are required to verify the reported preliminary observations.

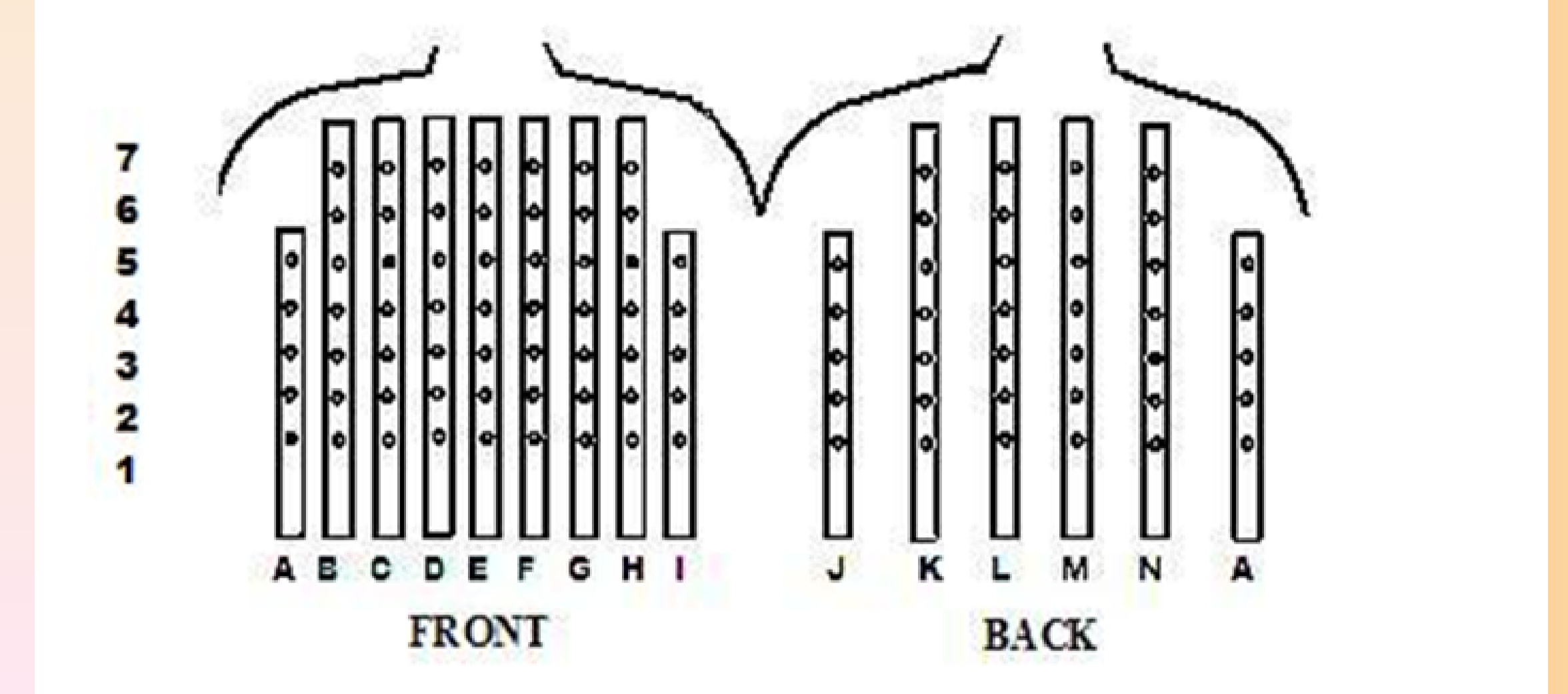


Fig.1. Layout of electrodes on patient's thorax. The tapes are marked with letters, while the electrodes

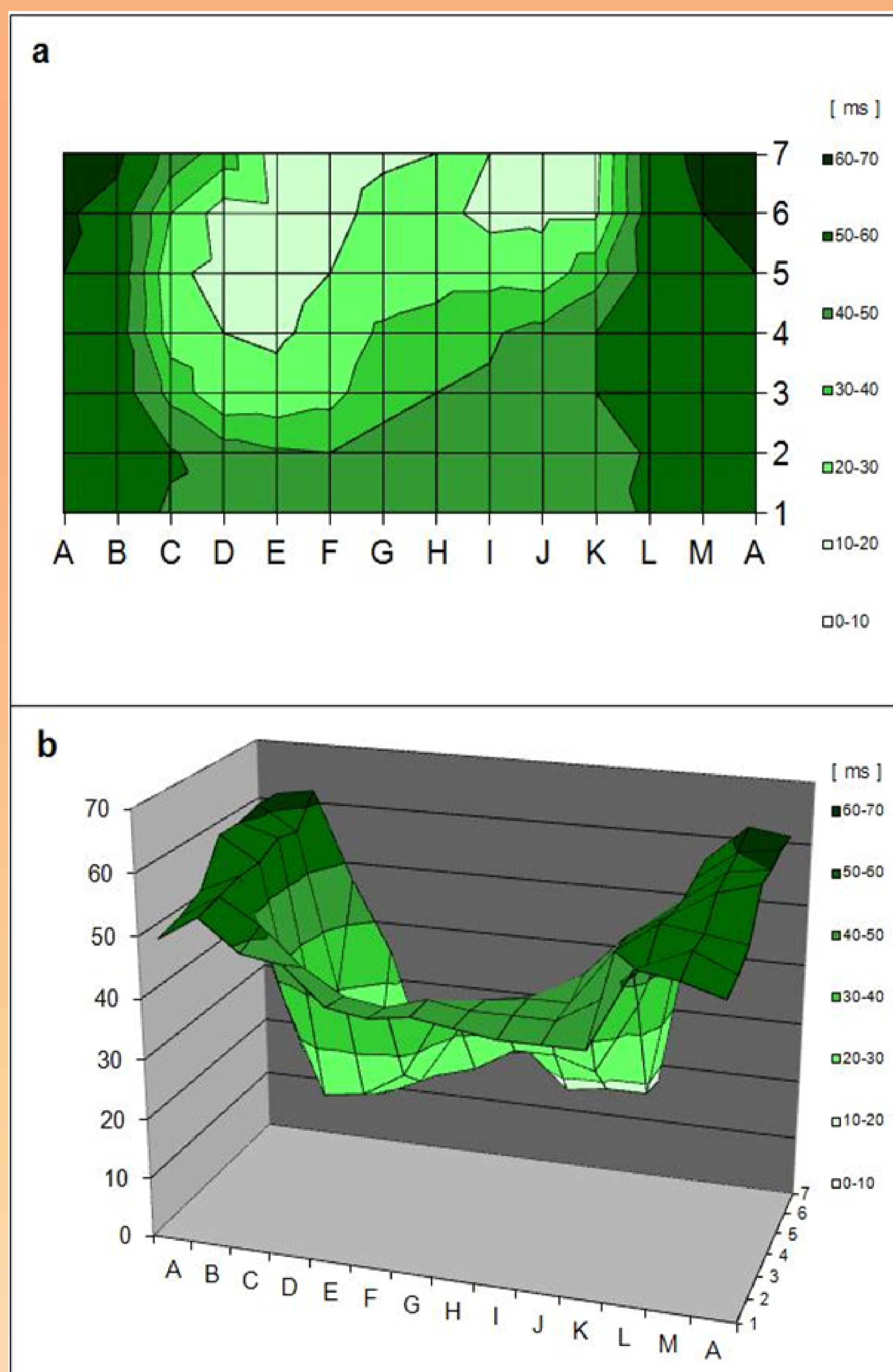


Fig.2. VAT-mean map from the control group. map a – on the plane, map b – in the space (3D-3-dimensional view)

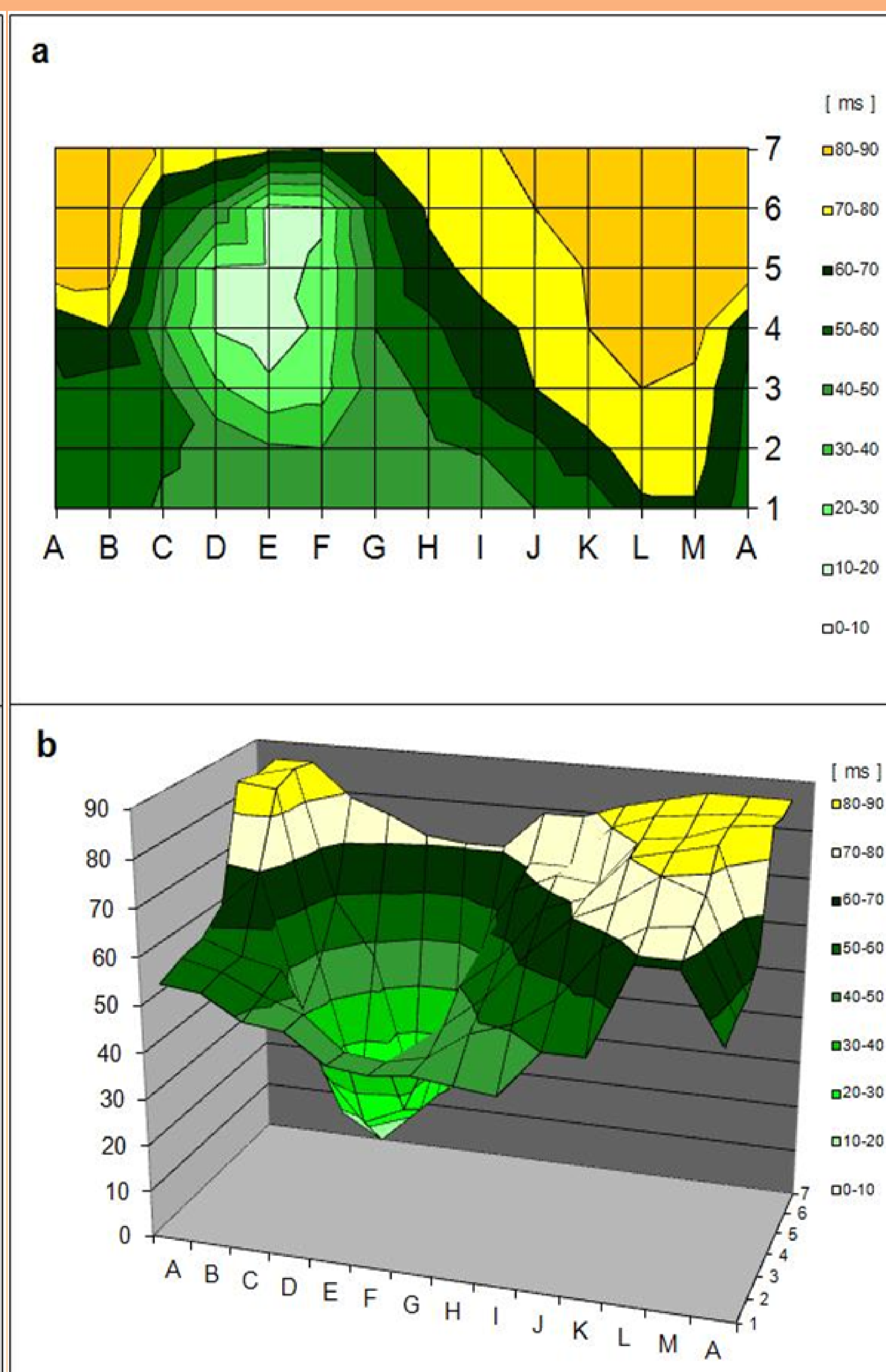


Fig.3. VAT-mean map from the ESRD children on peritoneal dialysis. map a – on the plane, map b – in the space (3D-3-dimensional view)

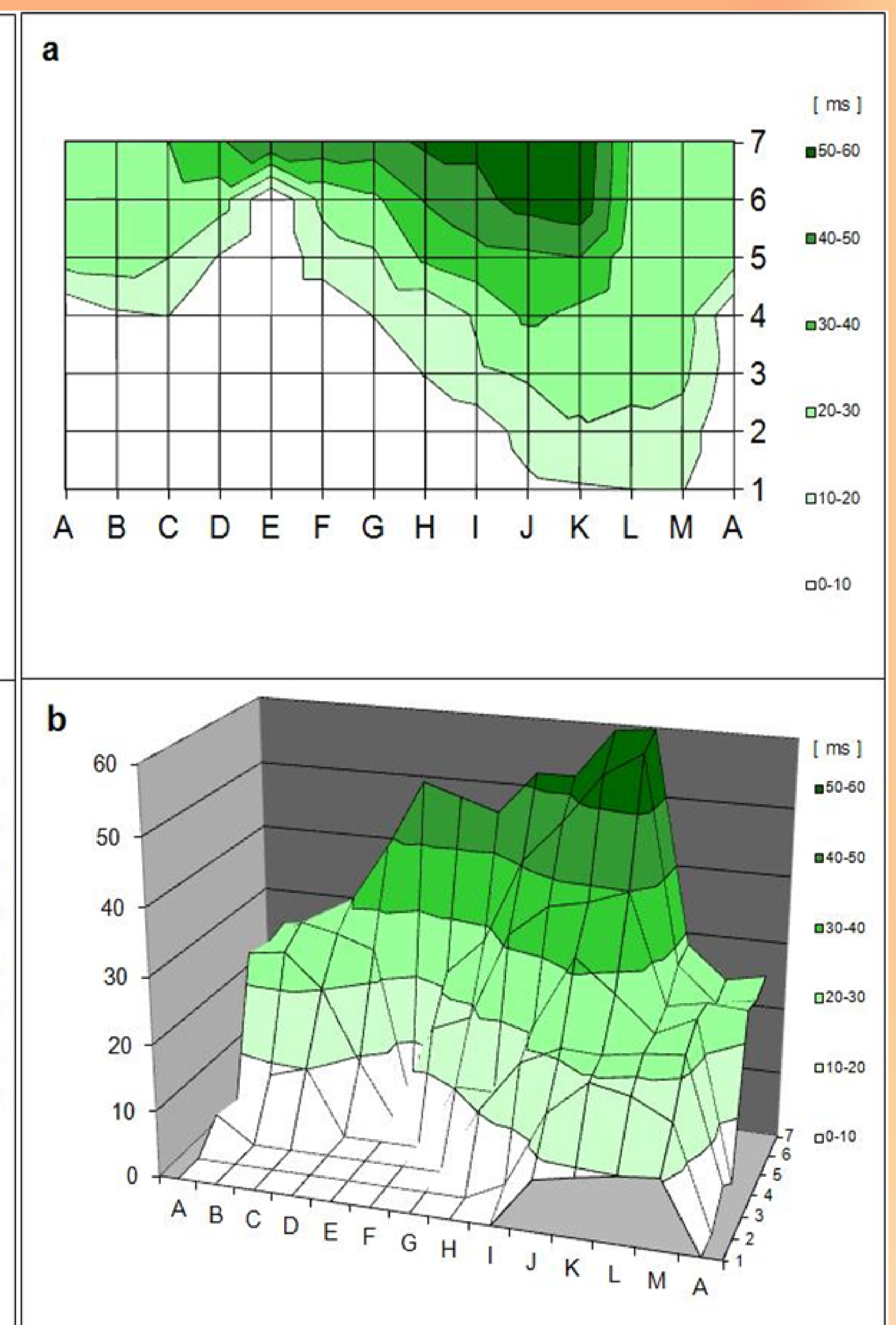


Fig.4. Presents a map of statistically significant differences (with consideration of the confidence interval), calculated from VAT values in particular monitoring sites, indicated on the averaged isochrone maps for the studied groups. Maps a and b illustrate the distribution of isolines: map a – on the plane, map b – in the space (in order to more precisely localise the changes).

