PRACTICAL SYSTEM FOR BSP MAPPING STUDIES

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Abstract

Experience with the use of practical body surface potential mapping system is described in the paper. Its great advantage is that full-value system can be simply created by connecting dedicated patient terminal box to the parallel port of a notebook or desktop PC. The modular software package enables to use different mapping techniques for electrocardiologic diagnostics and for electrophysiological studies. Using several mapping lead sets, the system has been used for non-invasive estimation of MI position and size, for long term evaluation of the heart state changes after MI or for preoperative localisation of the accessory pathway in WPW.

1. Introduction

It is known that body surface potential (BSP) maps depicting detailed potential distribution over the chest surface can help in diagnostics and treatment of heart diseases. However, the need for a big number of measured leads can make the real measurement quite cumbersome. Design of a suitable practical mapping system is therefore an important step in making this techniques acceptable for routine use.

In the paper we present a portable PC-based system enabling to use different electrocardiographic mapping techniques based on several limited and full grid lead sets.

2. Material and methods

Specialised patient terminal for multichannel ECG measurements was developed to fulfil the requirements for practical mapping device. When connected to a notebook or desktop PC using the parallel port, portable mapping device enabling simultaneous measurement of up to 135 ecg signals is created as shown in Fig.1 .

The patient terminal contains ECG amplifiers, data acquisition system and PC interface and conforms with all safety requirements for an ecg measuring equipment. The ecg amplifiers are placed in one 7-channel limb lead module and in up to eight 16-channel unipolar chest lead modules. Frequency response of the amplifiers is programmable, contacts of electrodes are continuously checked. The data acquisition system (DAS) contains analogue multiplexer, programmable gain

amplifier, 12 bit A/D converter, optical isolation and IEEE 1284 compatible fast bi-directional parallel interface controller.

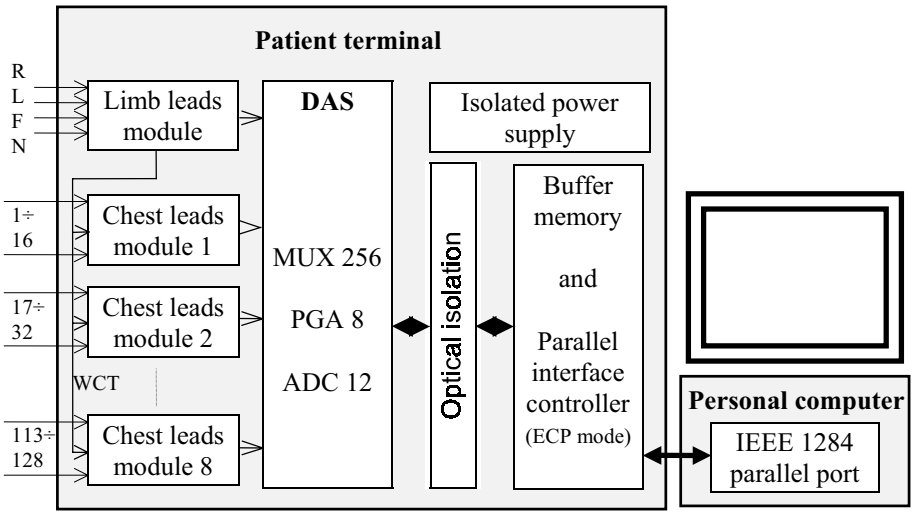

Fig.1. Block diagram of the mapping system

Modular software package developed for the device enables ecg measurement, processing and computation of several types of body surface maps.

ECG signals are measured using standard lead systems (12 lead ECG, Frank VCG) and several lead systems for BSP mapping (with 24, 32 or 63 leads or with up to 128 leads in any regular grid). Gains in measuring channels are automatically set to an optimum and selected signals can be continuously monitored on the screen.

Measured ecg data can be digitally filtered and their baseline can be corrected. QRS complexes and baseline instants before P-wave and after T-wave are identified automatically. Another characteristic instants in ecg signals can be marked by the user, amplitudes and times can be measured on the screen.

Different types of body surface maps can be constructed from processed ecg signals using corresponding reconstruction and computation techniques. Potential maps are computed in selected instants within 1 to 12 selected time sequences, integral maps are computed as integrals of ecg potentials over selected time intervals defined by marked instants or directly in milliseconds. Mean integral maps (templates) are computed for a group of patients and departure index (DI) maps are used as a measure of deviation of an individual patient map from the template. In isochrone mapping, characteristic times when ecg signals reach extreme value,

selected threshold or minimal derivative as well as QT-interval duration can be mapped and displayed.

3. Results

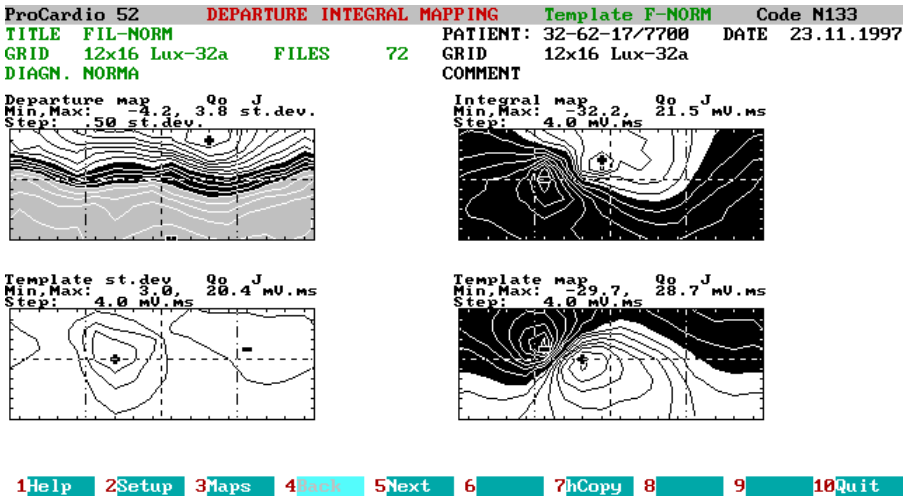

Fig.2. Departure and integral map of QRS complex in a patient with inferior MI. Area where the DI exceeds a significant value is marked by light shading.

As an example, departure index map of the whole QRS complex (Qo-J map) in a patient with acute MI is shown together with corresponding patient integral map, template map and map of template standard deviations is shown in Fig.2.

Isochrone map showing the times when ecg potentials reach the 50 μV threshold in a patient with acute MI in LV inferior and posterior wall is presented in Fig. 3. In corresponding parts of the map no potentials above the threshold were detected.

4. Conclusions

Among others, the system has been used for non-invasive estimation of the position and size of myocardial infarction [1] or for long term evaluation of the heart state changes after MI [2]. As shown in a model study, high quality measured signals provide maps with acceptable precision for inverse computation of equivalent cardiac generator parameters [3] and can help in preoperative localisation of accessory pathways in WPW syndrome [4].

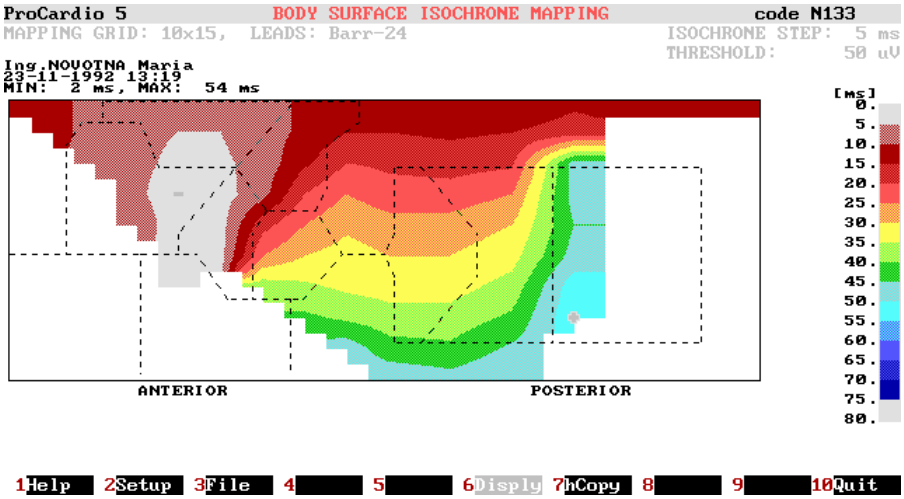

Fig. 3. Isochrone map showing 50 µV threshold times in a patient with acute MI. Missing potentials above the threshold are in the lower left and right anterior chest.

From the experience with the mapping device we have concluded that it represents a flexible and practical solution for different types of electrophysiological studies and for electrocardiologic diagnosis. Its main advantages are easy setup, portability and possibility to use several built-in mapping lead sets.

Acknowledgement

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References

1. Filipová S., Cagáň S., Dúbrava J., Tyšler M., Kneppo P., Rosík V.: Diagnostic application of body surface mapping in clinical cardiology: the role of the norm definition for the correct using of the integral departure mapping In: Advances in body surface mapping and high resolution ECG. Yasui S., Abildskov J.A., Yamada K., Harumi K., Eds. Nagoya: Life Medicom Co, 1995: 109-123.
2. Kozlíková K., Hulín I., Murín J., Tyšler M., Bakošová M., Bulas J.: Long-term study of heart activation changes displayed in body surface isochrone maps with threshold potential. In: XXIVth International Congress on Electrocardiology, Abstract book. Bratislava, 1997: 45.
3. Tyšler M., Turzová M., Švehlíková J., Tiňová M., Kozlíková K.: Noninvasive localization of preexcitation sites using experimental data. In: XXIVth International Congress on Electrocardiology, Abstracs. Bratislava, 1997: 105.

4. Hatala R., Kaltenbrunner W., Kozlíková K., Bernadič M., Tyšler M., Hulín I., Steinbach K.: Nichtinvasive Lokalisationsdiagnostik der akzessorischen Leitungsbahnen mittels transthorakalem EKG-Mapping. Acta Medica Austriaca 1995; 22, Sonderheft 1: 56.