The Processed Map of the Body Surface Potential

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As the processed maps, the variance map and the residue which was the ratio of the nondipolar cardiac field were introduced. The variance map was made from the root mean square of the distance from the mean value of QRS, T or QRST. The variance map may be useful to find the area of the peak variation of QRS, T or QRST on the body surface.

The residue is the expression how much was the nondipolar component included in the body surface potentials. This may be relevant to detect the abnormal cardiac potentials included in the body surface potentials.

There may be 2 ways for the analysis of the body surface potential maps. One is the recognition of the pattern of each frame of the body surface map, and the other is the processed maps induced from the maps. The averaged maps of QRS, T and QRST, the departure maps, vulnerable index and others have been introduced.

We have been developing a couple different processed maps, and the variance map and the ratio of nondipolar cardiac electrical field will be introduced in the following.

The Variance Map

The variance map is a kind of the root mean square map. For the variance maps of QRS, T or QRST, the mean value was obtained from the QRS, T or QRST area as shown in Fig. 1. The distance from the mean value in each instance of QRS, T or QRST was measured, summed, averaged through the duration and the root value was calculated in each leads, and the map was made. The variance map may be relevant to recognize the distribution of the cardiac potential on the body surface, which may be contributed by the volume conductor and also by the cardiac electric source. An example of the variance map is shown in Fig. 2. Figure 2-A is the variance map limited to the anterior chest of QRS, T and QRST in a normal case. The peak value was observed in the left anterior chest similarly in 3 maps. Figure 2-B is a case of spontaneous pneumothorax. The left side is the map in the acute stage and the right is the map after recovery. In the acute stage, the main potential variation was located in the center and right side of the chest, compared to the maps after recovery of which maximum potential variation was observed in the left lateral side and was comparable to the normal case of Fig. 2-A. The variance map may be useful to identify the location of the maximal potential variation and also the multiple peak of the potential variations in the abnormal cases.

The Nondipolar Component in Body Surface Potential

The method to estimate the location and the vector components of the instantaneous equivalent cardiac dipole from the body surface potential was already introduced. The process is the following. The potential (φ cal) on the boundary

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plane produced by assuming electrical dipole in a uniform conductor was calculated. The position and the vector components of the instantaneous cardiac equivalent dipole were estimated, when the difference between the observed body surface potential (\(\phi\) obs) and \(\phi\) cal was minimum. Figure 3 showed the instantaneous value of the ratio of nondipolar cardiac field estimated from the body surface potentials to the total body surface cardiac potentials. The lower column was the instantaneous root mean square value of QRS and T in 2 msec step. The upper column was the instantaneous value of the ratio of the difference (the residue). The increased value of the residue means the increased nondipolar component included in the body surface potentials. In this particular normal case, the residue means less 20% in the initial 40 msec of QRS, and is increased up to 40% at the notched part of the later 40 msec of QRS. The residue during T is quite stable and about 20%. These patterns of the residue were almost similar in the 5 normal young cases. The late high value of the residue

Fig.1. Determination of the value of the variance in each electrocardiogram.

\[
\text{Var}(x,y) = \frac{1}{T} \int_{t=t_0}^{t=t_0+T} \left[ \psi(x,y,t) - \bar{\psi}(x,y) \right]^2 dt
\]

\[
\bar{\psi}(x,y) = \frac{1}{T} \int_{t=t_0}^{t=t_0+T} \psi(x,y,t) dt
\]

Fig.2. The variance map. The map shows the variance map of the anterior chest from the right anterior axillary line to the left anterior axillary line. A: a normal case, B: a case of the spontaneous pneumothorax in the left thorax

(A) VARIANCE MAP
   —NORMAL—

QRS

T

QRST

(B) VARIANCE MAP
   SPONTANEOUS PNEUMOTHORAX
   —LEFT SIDE—

QRS

T

QRST

BEFORE TREATMENT

AFTER TREATMENT

Fig. 3. The ratio of the nondipolar cardiac electrical field (the residue) of the body surface potential in normal case. Upper column: the residue; Lower column: the root mean square of QRST

might be comparable to zone of nonsingle dipolarity described by Taccardi. The residue would be relevant to recognize the abnormal cardiac electrical field of the body surface potentials.

REFERENCES


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