

ブタ心臓壁における収縮応答の伝播速度の心筋虚血による低下の超音波計測

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抄 録

目的：心筋虚血を発症した際、早急な再灌流により心筋の壊死を回避するため、心筋虚血部の範囲と程度の迅速な同定が虚血性心疾患の診断とその後の的確な治療において重要となる。本論文では、複数のブタ心臓において、虚血後の数秒間で、心筋の収縮応答の伝播速度が低下することを超音波計測により定量的に検出する。**方法**：開胸ブタ5頭の心室中隔壁に関して超音波計測し、その後、左前下行枝を駆血することで心室中隔壁を虚血状態にして数秒以内に再度計測を行った。取得RF信号に位相差トラッキング法を適用し、心室中隔壁内に設定した約3,000点で各々微小振動速度を求めた。各点での微小振動速度波形に相互相関法を適用し、収縮応答の伝播を遅延時間の空間的な推移として描出した。**結果**：開胸ブタ5頭の心室中隔壁において、心筋収縮応答は心基部側から心尖部側へ伝播することが確認された。伝播速度は、正常状態では 2.7 ± 0.5 m/sでほぼ一定であるのに対し、冠動脈駆血から約5秒後では 1.9 ± 0.5 m/sと約31%低下し、さらに約7秒後においては 1.4 ± 0.3 m/sと約50%低下することが超音波により計測された。**結論**：ブタ5頭に関して、正常状態と虚血状態にかけての約7秒間に心筋収縮の伝播速度が約50%低下することが検出されたことから、心筋虚血部を超音波によって非侵襲的に同定できる可能性が示唆された。

Ultrasonic detection of decrease in propagation velocity of contraction response due to myocardial ischemia in swine heart wall

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Abstract

Purpose: Fatal necrosis of the myocardium can be avoided by prompt reperfusion at the onset of myocardial ischemia. Therefore, rapid identification of the range and degree of the ischemic regions is essential for diagnosis and subsequent correct treatment in the early stage of ischemic heart disease. In this paper, the decrease in the propagation velocity of the myocardial contraction response after ischemia is detected quantitatively in several seconds by ultrasonic measurements in multiple swine hearts. **Methods**: Ultrasonic measurement was applied to the interventricular septum (IVS) of five open-chest swine under normal conditions. Ischemia in the IVS was then induced by avascularizing the left anterior descending (LAD) coronary artery, and ultrasonic measurement was applied to the ischemic IVS within several seconds. By applying the phased-tracking method to the acquisition RF signals under each condition, velocity waveforms with minute vibration were simultaneously obtained at about 3,000 points in the IVS. Moreover, using cross-correlation between the resultant vibration velocity waveform at each measurement point and that at the reference point, the propagation of the myocardial contraction response was visualized as spatial transition of the delay time. **Results**: In the IVS of five open-chest swine, the myocardial contraction response propagated from the basal side to the apical side. The propagation velocity was almost constant at 2.7 ± 0.5 m/s under normal conditions. On the other hand, an approximately 31% decrease in the propagation velocity to 1.9 ± 0.5 m/s was observed about 5 seconds after LAD avascularization. Furthermore, about 7 seconds after LAD avascularization, an approximately 50% decrease in the propagation velocity to 1.4 ± 0.3 m/s was observed. **Conclusion**: In five swine, the propagation velocity of the myocardial contraction decreased by about 50% in about 7 seconds from a normal to ischemic state. This suggests that myocardial ischemic regions can be identified noninvasively by ultrasonic measurement.

Keywords

echocardiography, myocardial contraction, propagation of contraction, phased-tracking method, ischemia

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