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Multi monitoring via ablation catheter for estimation of myocardial mechanical properties

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***Abstract*— We estimated the mechanical properties of myocardium by combined transcatheter monitoring of local impedance and contact force.**

***Clinical Relevance*— This mechanical properties measurement might guide the optimal ablation conditions and resulting to reduce serious complications such as cardiac tamponade during radiofrequency catheter ablation.**

I. INTRODUCTION

Radiofrequency catheter ablation (RFCA) is an effective treatment for tachyarrhythmia [1]. Catheter-tissue coupling during RF energy application is important to create sufficient lesions and block tachycardia circuits. Contact force (CF) value was reported to correlate with lesion size, and CF monitoring is widely used in RFCA [2]. However, suitable CF would be different among tissue, and it might be excessive at vulnerable sites, so the risk of serious complications such as cardiac tamponade would not be solved using only CF monitoring. The evaluation of myocardial mechanical properties, such as stiffness and thickness, might be useful to solve these problems. In recent years, catheters that can measure local impedance (LI) between the tip electrode and proximal ring have developed [3-4]. The dependence between LI and the distance from the tissue to the catheter tip was reported [5]. The information about myocardial mechanical properties would be obtained by combination of LI measurement for strain estimation and CF measurement. In this study, we measured LI and CF simultaneously using left ventricular (LV) and right atrium (RA) of porcine hearts *in vitro* to develop novel transcatheter monitoring.

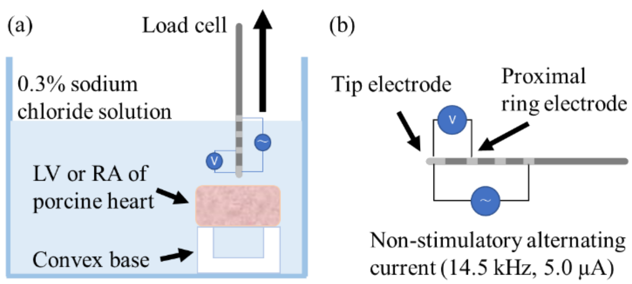

Figure 1. The schematic illustration. (a) the experimental setup for LI and CF measurement of porcine heart *in vitro*. (b) structure of catheter tip.

II. METHODS

A 4.5 mm open-irrigated ablation catheter (INTELLANAV MIFI™ OI, Boston Scientific, Maple Grove, MN, USA) was used. The MIFI™ OI ablation catheter has 3 microelectrodes incorporated within the tip electrode. LI was measured between the microelectrodes and the proximal ring of the ablation catheter by being driven non-stimulatory alternating current (14.5 kHz, 5.0 µA). LV and RA of porcine heart were cut and set onto silicon convex base in 0.3% sodium chloride solution at 37 ℃ to simulate intracardiac blood (Fig.1). The catheter tip was pushed into LV and RA epicardium at a constant velocity while measuring LI, CF, and catheter displacement. CF was measured by a load cell (DPU-2N, Imada Co., Ltd., Toyohashi, Japan) and the catheter displacement was measured by video recording.

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III. RESULTS & DISUCUSSION

Table 1 shows slope and coefficient of determination of linear function fitted to CF change with LI. In the case of LV, which is relatively thick and stiff, the slope was larger than that of RA. This result suggest that this combined transcatheter monitoring is capable to evaluate mechanical properties including tissue thickness and stiffness.

Table 1. the parameters of linear function fitted to CF change with LI

sites	slope	R^2
RV	0.46	0.90
LV	0.28	0.89

IV. CONCLUSION

We distinguish myocardial tissue with different mechanical properties by combined transcatheter measurement of CF and LI. Simultaneous measurement of LI and CF may enable transcatheter investigation of myocardial properties and provide useful information for determining the optimal ablation conditions for the tissue.

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