Characterization of bileaflet mechanical heart valves closing sound

Hemodynamic performances of any bileaflet Mechanical Heart Valve (MHV) can be affected by the formation of thrombotic deposits whose early detection could be fundamental for prompt diagnosis and adequate therapy. This study aims at designing a diagnostic tool able to detect valvular thrombosis at early stages of formation and assign each MHV recipient to a risk class.

The proposed approach is based on feed-forward artificial neural networks applied to the power spectra of the signals produced by the closing sounds of MHVs leaflets. Five bileaflet MHVs were investigated in a Sheffield Pulse Duplicator. Six functional conditions were reproduced (Figure 1): one normofunctioning (Nf) and five thrombosed, which have been simulated by placing artificial deposits of increasing weight and shape on the valve leaflet (I1, I2, I3) and on the annular housing (Hg); the case of one completely blocked leaflet was also investigated (Bk).

In vitro, the acoustic signals (e.g., closing sounds) were acquired by phono-cardiographic means, then analyzed in terms of power spectra (Figure 2) and finally classified by an artificial neural network. The neural network, trained with the in vitro data, was also used to classify the acoustic signals from 48 recipients of one MHV in the aortic position. For all patients four recordings were acquired: the average spectrum was calculated to reduce intra-operator variability. The average spectrum was classified and assigned to a risk class. From the average spectra acquired from the patients, 38 spectra (80.85%) were clearly assigned to the proper risk class by the artificial neural network.

The implementation of a diagnostic tool able to detect thrombotic formations on MHVs leaflet and then assign patients to one of the six risk classes, can help clinicians in establish adequate therapeutic approaches before the appearance of critical symptoms due to prosthetic valve thrombosis.

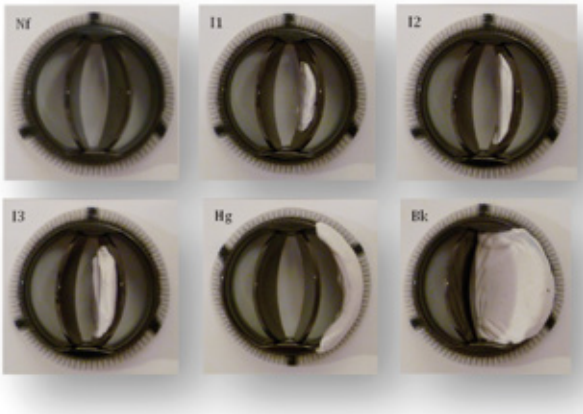

Fig. 1. The six simulated functional classes for in vitro tests.

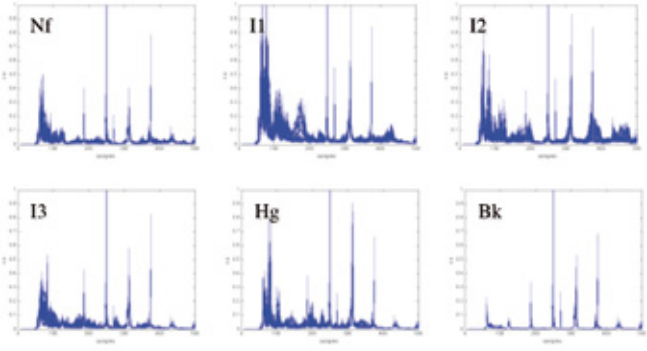

Fig. 2. The average power spectra calculated for the six simulated functional classes.

Bioingegneria, biotecnologia e tecnologie per la salute
Bioengineering

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