Myxomatous mitral valve disease (MMVD) is the most common acquired cardio-vascular disease in dogs, and accounts for approximately 75% of cases of chronic heart failure. The etiology of the myxomatous process is still unknown . Myxomatous mitral valves are characterized by a disorganization of the structural elements of the leaflets and a weakening of the chordae tendineae (ChT) as well. Chordae tendineae are a key biomechanical point responsible for the opening and tight closure of the valve leaflets. During the course of the disease, an episode of ChT and papillary muscles rupture can occur, most often resulting in a state of valve regurgitation and the development of acute pulmonary edema, a potentially life-threatening episode for the canine patient. Little is known about the biomechanics of the ChT in dogs with mitral valve disease. The structure of ChT allows their high deformability in the axial direction during cyclic operation of heart valves. Knowledge of the mechanical parameters is important for the proper assessment of the condition and functionality of the chordae tendineae, as well as for the development of new techniques for the reconstruction of ruptured ChT. The treatment of mitral regurgitation in dogs largely depends on the condition of the canine patient and often carries a high risk. The most common treatment is the administration of pharmacological agents, as well as surgical annuloplasty, mitral valve replacement, percutaneous ValveClamp clipping, or ChT replacement by replacing it with a polymer tendon. Each of these methods has a high risk of failure or life-threatening complications for the canine.

It is hypothesized that restoration of the functional deformability of the ChT structure that connects the papillary muscles to the valve leaflets will make it possible to achieve repeated valve tightness and reduce volume overload states of the left atrium and left ventricle against heart failure. These conditions lead to the development of acute pulmonary edema, which is potentially life-threatening for canine patients.

Based on the results of previously performed research, our investigator team concluded that this research should be continued and expand their scope and in consequence the aim of the project will be to formulation of the conditions of operation of an implant connecting the chordae tendineae to the papillary muscle minimizing the adverse effects of implant activity on the dynamics of deformation changes of the valve-muscle system, and to determine the conditions of proper joining of materials reducing the risk of the disorders during valve movement caused by implantation and potential complications existing during and after surgical surgery.

The project is planned to include 4 tasks.The project plans to collect post-mortem material from about 60 canine patients of the Veterinary Clinics operating at the Wrocław University of Environmental and Life Sciences.

In the 1 task, the following will be carried out histologic, immunohistochemical and molecular examination with the analysis of echocardiographic parameters of mitral valve structures.The key point is to evaluate the amount of various types of collagen and elastin, their realationship in the structures of mitral valve. Knowledge of the structure, qualitative and quantitative ratio of individual fibers in the normal state and with diagnosed MMVD in dogs will be the basis for the development of a mathematical description for the ChT and papillary muscle.

In the 2 task, tests will be performed a static tensile test will be performed on a testing machine correlated with a digital image correlation system for microscale testing (microDIC) for ChT and papillary muscle. The results obtained will become the basis for the determination of strength parameters and preliminary fitting of the mathematical model of the material.

In the 3 task based on the theory of constitutive equations describing string hiperelastic materials such as Holzapfel's model the numerical model will be formulated. For material models of tissues the behaviour of mitral valvewill be simulated for different conditions as the result of change the tissue mechanical characteristic and implant influence. The result of task will determine a modelfor mitral valve structures and its behaviour will be described for better understanding right working of this valve after implantation.

In the 4 task, an analysis of the conditions for the functioning of the implant integrating the papillary muscle and chordae tendineae will be performed. Based on the results obtained from the previous tasks, the recommendations necessary to realize the conditions for the implant-valve system to function will be determined. 3 materials that could meet the described conditions will also be investigated.

As a result of the project, the knowledge of biomechanical and morphometric relationships of the papillary muscle and chordae tendineae in the mitral valve of the canine heart will be increased. This relationship will be described using a constitutive mathematical model combining the structural structure and mechanical properties of the structures that construct the mitral valve.

Guidelines will be developed for the construction of synthetic ChT that reproduce the deformability of the normal mitral valve. This will contribute to the development of a new, effective technique for treating mitral valve regurgitation and preventing the occurrence of life-threatening conditions in canine patients.