

ELASTIN AND COLLAGEN FIBRES ALTERATIONS FOR ABDOMINAL AORTIC ANEURYSMS POPULATION WITH CONSTANT MAXIMUM DIAMETER SIZE

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Abstract

Development of abdominal aortic aneurysm (AAA) is a dynamic process proceeding as a result of the multi-factor pathological remodelling of elastin and collagen fibres, results an aneurysm expansion. In clinical practice, development of AAA is identified with aneurysm growth. Hence, the aim of this paper is to propose a taxonomy of load-bearing structural components alterations for AAA with relatively constant maximum diameter (average diameter 6.9 ± 0.8 cm). Structural investigations of normal ($n=47$) and aneurysmal ($n=46$) vessels were carried out on the basis of histological and ultrastructural examinations. The histological preparations were subjected to histometric evaluation; the number of collagen and elastin fibres and additionally the thickness of the particular vascular wall layers. A qualitative analysis of the abdominal aortic wall, mainly estimation of fibres arrangement, based on histological and ultrastructural (SEM) examinations were additionally performed. Using a cluster analysis, three stages of load-bearing fibres alterations for AAA population were distinguished. The clusters were systematized according to NAA results. For AAA population with relatively constant maximum diameter in the first stage of load-bearing fibres remodeling was observed a substantial loss of elastin fibres. The second stage is characterized by an increase in the number of collagen fibres. In the final stage the number of collagen is dramatically reduced. Presented results provide evidence to risk of AAA rupture is not connected with AAA size but a remodelling of extra-cellular matrix proteins. The remodelling is accompanied by changes in the AAA wall thickness, which should be taken into consideration when evaluating the degree of advancement of this disease.

Keywords: abdominal aorta, aneurysm, elastin fibres, collagen fibres, maximum diameter size, cluster analysis

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FIBROBLAST BIOLOGICAL ACTIVITY ON POLY(L-LACTIDE) AND POLY(L-LACTIDE-CO-TRIMETHYLENE CARBONATE)

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Abstract

Poly-L-lactide (PLLA) is acknowledged biocompatible polyester. However, it possesses high crystallinity/brittleness/stiffness and requires long time for complete degradation. In the current study we present data on PLTMC, a copolymer of L-lactide and trimethylene carbonate (TMC). Poly(trimethylene carbonate) (PTMC) is characterised by good mechanical properties and rapid degradation rate and for this it might possess new desired features for medical applications. During the experiments, adhesion and activity of fibroblasts cultured on PLLA and PLTMC were studied and compared during two time points of 3 and 5 days. On day 3, the number of adherent fibroblasts was compromised when fibroblasts were cultured in the presence of PLTMC but the proper adherence was recovered by day 5. The same pattern was observed when we evaluated some activity parameters of fibroblasts. In particular, the release of proteins and nitric oxide was studied as the increased levels of the mediators might indicate unwanted inflammatory-like condition. Overall, the results suggest that the synthesized PLTMC initially shows unwanted effects on fibroblasts but with the time these effects are abolished. Therefore PLTMC seems to represent a new material that is non-cytotoxic and compatible with the living cells.

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CHEMICAL MODIFICATION OF POLY ϵ -CAPROLACTONE WITH WOLLASTONITE AND ITS INFLUENCE ON BIOLOGICAL PROPERTIES OF OSTEOBLAST LIKE-CELLS MG-63

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Abstract

PCL (poly-ε-caprolactone) is a biocompatible and biodegradable polymer of aliphatic polyester group. However, PCL does not effectively bind to the bone in contrast to bioactive inorganic compounds such as wollastonite. For this wollastonite (WS) is regarded as a potential bioactive material for bone tissue engineering although its main drawback is brittleness. Therefore we synthesized polymer nanocomposite materials composed of poly-ε-caprolactone and wollastonite (PCL/wollastonite) containing either 0.5% or 5% of the latter modifying filler. And we aimed to verify biological properties of the nanocomposite PCL/WS materials, in comparison to the pure PCL, on cultures of osteoblast-like cells MG-63. The study revealed that the adherence of the osteoblast-like cells to the tested materials was enhanced by the PCL modification (PCL/5WS > PCL/0.5WS > PCL) while cell viability/proliferation was not altered. Furthermore, the activity of alkaline phosphatase indicative of osteoblast differentiation (maturation) was enhanced when the cells were cultured with either PCL/5WS or PCL/0.5WS. Overall, our results indicate that PCL-modified wollastonite improves biological properties of the basic biomaterial suggesting its potential usefulness/application for the bone tissue regeneration.

Keywords: polycaprolactone, wollastonite, osteoblast-like MG-63 cells, cell adhesion, viability, proliferation, alkaline phosphatase

[Engineering of Biomaterials/Inżynieria Biomateriałów, 102, (2011), 11-14]

BADANIA BIOLOGICZNE WARSTW POWIERZCHNIOWYCH W ASPEKTCIE ZASTOSOWANIA NA PIERŚCIEN ZASTAWKI SERCA

BIOLOGICAL PROPERTIES OF SURFACE LAYERS FOR RING OF HEART VALVE APPLICATION

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Streszczenie

Oryginalna sztuczna komora wspomaganie serca POLVAD opracowana w Polsce, została zastosowana dotychczas w leczeniu ponad 210 pacjentów. Najdłuższe wspomaganie serca za pomocą komory POLVAD trwało ponad rok. Dla protezy tej opracowywana jest innowacyjna zastawka dyskowa, z nisko profilowym pierścieniem wykonanym ze stopu tytanu. Dla zminimalizowania trombogenności pierścienia zastawki opracowano dyfuzyjne warstwy powierzchniowe: azotowaną typu TiN+Ti₂N+αTi(N) i tlenoazotowaną typu TiO₂+TiN+Ti₂N+αTi(N), wytwarzane obróbką jarzeniową na potencjale plazmy. Trombogenność różnych kompozycji warstw została porównana w aspekcie aktywacji i adhezji płytek krwi do powierzchni biomateriału. Oceniono również wpływ metody sterylizacji biomateriału na intensywność adhezji trombocytów do jego powierzchni. Warstwy TiN oraz TiO₂ wykazały najniższą trombogenność, przy czym dla warstwy TiN korzystniejsza jest sterylizacja gazowa, podczas gdy dla warstwy TiO₂ - sterylizacja plazmowa.

Abstract

The original ventricular assist device POLVAD developed in Poland was used in over 210 patients so far. The longest POLVAD heart assistance excided one year. The innovative tilting disk valve with low profile ring made of titanium is developed for POLVAD. To minimize the valve ring thrombogenicity the diffusive surface layers were manufactured: nitriding TiN+Ti₂N+αTi(N) and oxynitriding TiO₂+TiN+Ti₂N+αTi(N), in the glow discharge process on the plasma potential level. The thrombogenicity of different layers composition was compared regarding platelets activation and platelets adhesion to the material surface. The influence of material sterilization method on the platelets adhesion intensity was evaluated in addition. The nitriding TiN and oxynitriding TiO₂ layers have demonstrated the lowest thrombogenicity while the gas sterilization was the most profitable for nitriding layers – TiN and the plasma sterilization for oxynitriding layers – TiO₂.

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ANALIZA UWARUNKOWAŃ DECYDUJĄCYCH O ODPORNOŚCI SZKLIWA NA ZUŻYCIĘ CZĘŚĆ II: BADANIA WARSTWY WIERZCHNIEJ ORAZ MIKROTWARDOŚCI SZKLIWA ZĘBOWEGO

THE ANALYSIS OF ENAMEL RESISTANCE TO WEAR DETERMINING FACTORS PART II: STUDY OF SUPERFICIAL LAYER AND MICROHARDNESS IN TOOTH ENAMEL

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Streszczenie

Opracowanie stanowi kontynuację zagadnień, w których wskazano uwarunkowania decydujące o odporności szkliwa naturalnego na zużycie. W części II opisano badania obejmujące ocenę stereometrii warstwy wierzchniej szkliwa z wykorzystaniem mikroskopii sił atomowych (AFM) oraz wyznaczenie mikrotwardości zębów z wykorzystaniem metody Oliver&Pharr.

Analizę statystyczną parametrów morfologicznych szkliwa z zębów przedtrzonowych i trzonowych przeprowadzono z zastosowaniem programu Scanning Probe Image Processor. Analiza pozwoliła identyfikować obrazy o różnym zakresie skanowania, wyznaczyć parametry chropowatości powierzchni na poziomie nano oraz różnicować struktury w sposób jakościowy i ilościowy. Zmiany chropowatości miały charakter okresowy o zbliżonych parametrach amplitudy, a częstotliwość była stała lub była wielokrotnością parzystą. Badania parametrów mikromechanicznych, poprzez nanoindentację, pozwoliły wyznaczyć twardość szkliwa oraz moduł sprężystości (Younga) na powierzchniach koron zębów trzonowych dolnych. Na podstawie charakterystyk wytrzymałościowych i pomiarów ustalono, że twardość zawarta była w przedziale od 337,2 HV do 335,3 HV, a moduł sprężystości w przedziale od 95,8 GPa do 106,3 GPa. Stwierdzono daleko posuniętą regularność w strukturach warstwy wierzchniej szkliwa oraz dużą powtarzalność w badaniach mikromechanicznych.

Słowa kluczowe: szkliwo zębowe, warstwa wierzchnia, chropowatość, mikrotwardość

Abstract

This paper is a continuation of the issues that has pointed determinants deciding about the resistance of natural enamel to wear. Part II contains the examinations including the assessment of enamel superficial layer stereometry using Atomic Force Microscopy (AFM) and determination of teeth microhardness using Oliver & Pharr method.

Statistical analysis of morphologic parameters in enamel from premolar and molar teeth was made using Scanning Probe Image Processor software. The analysis allowed the identification of images with various range of scanning, determination of roughness parameters of the surface in nanoscale and quantitative and qualitative differentiation of the structures. Changes in roughness are periodic, with similar parameters of amplitude, and a frequency can be constant or is an even multiple.

Determination of enamel hardness and Young's modulus for the surface of dental crowns in lower molar teeth were possible by micromechanical study using nanoindentation.

Based on performance characteristics and measurements it was established, that the hardness ranged from 337.2 HV to 335.3 HV, and Young's modulus ranged from 95.8 GPa to 106.3 GPa. Highly regular pattern in structures of enamel superficial layer and high repeatability in micromechanical examinations were found.

Keywords: tooth enamel, superficial layer, roughness, microhardness