RESEARCH ARTICLE

Biocompatibility and Haemocompatibility Assessments of RBC with Polymeric Coated Cardiac Stent

Chopade JV*, Hujare DP

Department of Mechanical Engineering, Dr. Vishwanath Karad MIT World Peace University, Pune, Maharashtra India.

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ABSTRACT

The current investigation was conducted to evaluate the biocompatibility and hemocompatibility of polymeric-coated cardiac stents. Coronary stents are typically small wire mesh tubes that are used to open arteries that are obstructed over time as a result of the buildup of fat, cholesterol, or other materials. A 10 milliliter isolated blood red blood cell was obtained using the Prozeta cobalt chromium coronary stent, which had the following specifications: stent length = 18 mm, strut thickness = 0.065 mm, expansion range = 2.25 mm to 4.00 mm, and burst pressure = 6ATM. Using an R&D coating equipment, polyethylene glycol (PEG) polymers were applied to the coronary stent. Assessments of the polymeric-coated cardiac stent's biocompatibility and hemocompatibility were conducted using various evaluation criteria. CAD software has been used to help with the stent's modeling. According to the supplied catalog, the strut's thickness and width are calculated to be 0.065 mm and its length is 18 mm. The histology of RBC in an isolated sample (polymer coated on stent) found at 2000 Rx was examined using a motic microscope. Using a UV-visible spectrophotometer set to 414 wave length, a 10µg/ml solution of RBC in distilled water was scanned at 200–500 nm to measure the UV absorption maximum. The absorbance was found to be 0.8312 nm. An FTIR analysis of RBC reveals absorptions that include bending and stretching vibrations. Peak Position was discovered at wave numbers 3661.76, 1684.62, 1547.98, 1472.07, 1278.06, and 841.98. Using SEM the surface morphology of RBC was study and it was found the measurements 6.1, 4.2, 3.3, 3.2, 3.1, and 2.2 µm in diameter with standard error 0.548584. It has been determined that PEG-coated material demonstrated significant outcomes that resulted in coronary stent that was both biocompatible and hemocompatible of polymeric-coated cardiac stent, which is a step towards altering the treatment regimen.

Keywords: RBC, Cardiac Stent, PEG, SEM, FTIR, Biocompatibility and Hemocompatible.

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INTRODUCTION

The condition of affairs known as biocompatibility occurs when a biochemical coexists with a body environment without substantially and unfavorably altering any other body of environment or material[1]. Biocomposites and any other materials used as medical devices need to be biocompatible[2]. Surface and structural biocompatibilities are the two broad categories into which biocompatibility can be divided[3]. In this section, we concentrate on surface biocompatibility; structural biocompatibility concerns are covered in later sections. The surface chemistry of the polymer matrix dominates that of the biocomposite since it is the continuous phase that contains the reinforcing phase[4]. The performance of biocomposite materials can have significant issues that are directly related to surface interactions[5]. The primary corpuscular component of blood are red blood cells (RBCs), which are biological entities with a size of microns. It travels to tiny capillaries from bigger arteries[6]. This work uses a physical approach to evaluate blood flow-governing features, specifically the mechanisms of RBC aggregation and disaggregation at the single-cell level.

MATERIAL AND METHODS

Stent material

Analytical grade polyethylene glycol was used as the coting material on the cardiac stent after isolated red blood cells were obtained from the authorized pathology laboratories in Pune, Maharashtra. Typically used to open arteries that have been blocked over time owing to the buildup of fat, cholesterol, or other substances, coronary stents are small wire mesh tubes.[7] A Prozeta cobalt chromium coronary stent was used, which had the following specifications: burst pressure = 6ATM, expansion range of 2.25mm to 4.00mm, strut thickness = 0.065mm, and stent length = 18mm[8]. Figure 1 shows the Coronary heard stent

Procedure for coating on stent

The conventional coating pan method involves rotating a circular metal pan on its horizontal axis. Coating solutions are sprayed onto

*Author for Correspondence: chopadejv91@gmail.com

Figure 1: Coronary heard stent

the revolving sample while heated air is delivered into the pan. A 100 microgram per milliliter PEG solution was made, and the stent was coated with a 10 micron layer using the subsequent process. First, get the coating solution ready, fill the pan with the sample, Use a spray nozzle to apply the coating solution to the sample and use hot air to dry the coating[9].

Testing of coated stent with RBC [10]

Using the centrifugation process (a Remi centrifuge machine) at 3000 RPM (revolution per minute) for 10 minutes at 15°C, red blood cells (RBCs) were separated from whole blood. Using a micropipette, each vial's supernant plasma was extracted. Centrifugation was performed three times with 1 ml of saline (Baxter Batch number 3672937) added to each vial. A micropipette was used to extract an RBC sample, which was then stored for UV light examination (power = 2 mW, wavelength X = 632 nm). After verifying the qualities of the RBC with the Histopathology assessment, place the coated stent in contact with the RBC and let it sit there for 24 hours[10].

RBC images by Motic Microscope

Analytical imaging is a subset of surface morphology. Certain surface morphological characteristics of polymeric materials influence their ultimate surface qualities, including wettability and adhesiveness in biocompatible procedures. The study of surface coatings to examine their microstructure both before and after the polymers are used is known as surface morphology[11].

UV-visible spectrophotometer

Spectra of RBC absorption measured with a UV-visible spectrophotometer (Jasco V-670) To obtain a different concentration, a 10 ppm solution of RBC was made, dissolved in distilled water, and then water was added to bring the volume up to 100 ml (100 ppm) [12]

Fourier Transform Infra Red Spectra of BRC

Functional group attached with the RBC was determine by FTIR technique, the isolated RBC sample was kept in sample holder in IR[13]

SEM of RBC by Scanning Electron Microscope

The surface morphology of a blood sample can be observed under a scanning electron microscope (SEM) at greater magnifications. They are used to examine blood cells at the cellular level. Under a SEM, the prepared blood samples were seen. The blood cell electron micrographs that are acquired can be utilized for cellular differential diagnosis[14]

RBC Properties

Using an autoanalyzer, measurements of specific gravity, density, osmotic pressure, pH for red blood cells, and erythrocyte sedimentation rate (ESR) were made[15]

RESULTS AND DISCUSSION

Stent modeling

The CAD program, was used to assist in the modeling of the stent. According to the supplied catalog, the strut's thickness and width are calculated to be 0.065 mm and its length is 18 mm (Figures 2, 3 and 4).

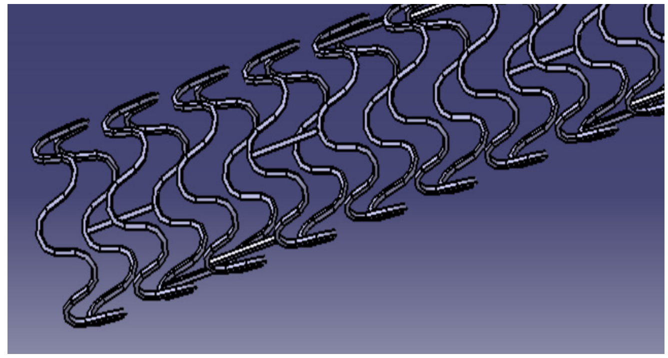

Figure 2: 3D view of coronary stent

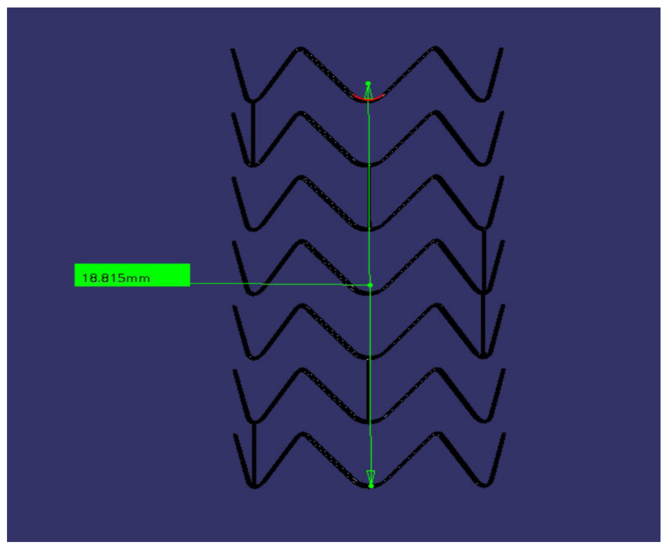

Figure 3: Length of stent

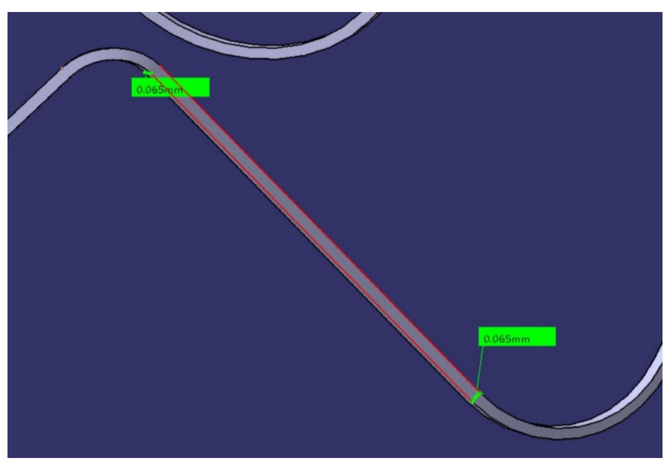

Figure 4: Strut thickness of stent

RBC images by Motic Microscope

Histopathology of isolated RBC and coated stent was tested by motic microscop and an electron beam powered by a tungsten filament as the light source, RBC samples on both sides were examined (Figure 5).

Absorption spectra of RBC

Using a UV-visible spectrophotometer set to 414 nm and absorbance of 0.8312, a 10µg/ml solution of RBC in distilled water was scanned at between 200 and 500 nm to measure the maximal UV absorption (Figure 6).

FTIR study

The RBC displays absorptions that are limited to the C-C, C-O, CH (methylene absorptions), and C-H bending stretching and bending vibrations. The region with the hydrogen bonded nature, 3378 cm-1, is where the OH stretching vibration is seen. the results are shown in Figure 7 and Table 1.

Scanning Electron Microscope

Utilizing scanning electron microscopy (SEM), the property of shape and size of modification in RBC was measured. The RBC SEM images after 24-hour period of RBC interaction in a PEG coated cardiac stent, Results are shown in Figure 8 and Table 2

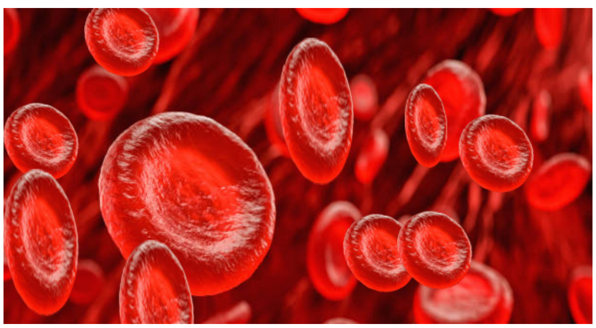

Figure 5: RBC in isolated sample (polymer coated on stent) find at 2000 Rx)

Table 1 : FTIR Results of RBC

S. No.	*Peak Position*	*Groups Present*
1	3639.12	O-H (Free group)
2	1654.43	C=O(Amide)
3	1536.65	N=O(Nitro)
4	1432.26	N=O(Nitro)
5	1265.33	C-O(Anhydrides)
6	839.87	C-H (Aromatic)

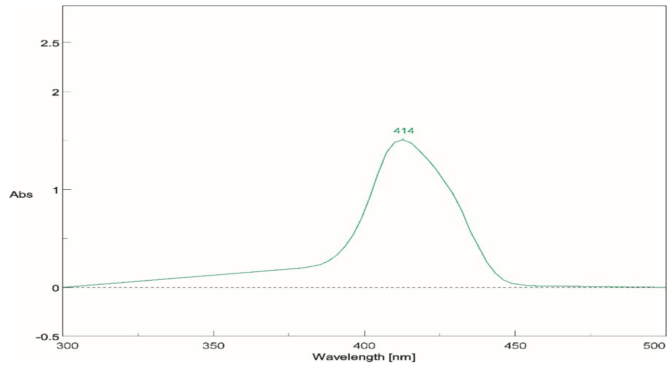

Figure 6: UV –Spectra of RBC

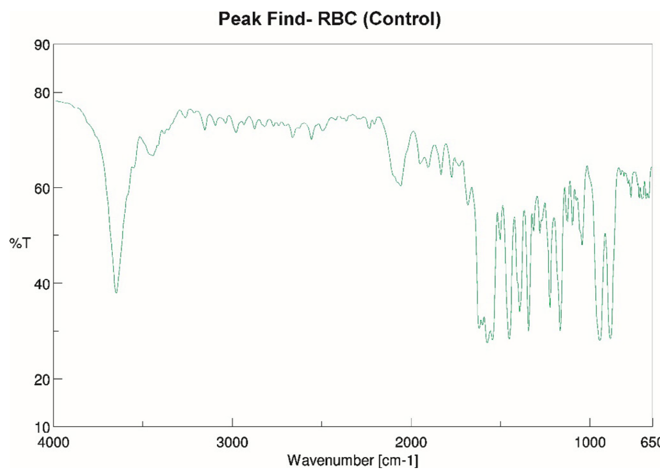

Figure 7: FTIR –Spectra of RBC

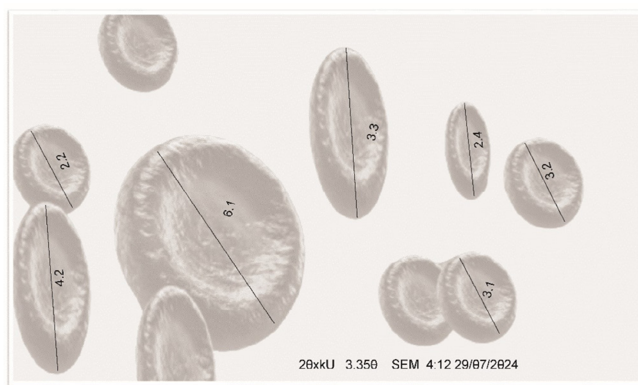

Figure 8: SEM of RBC

Table 2: SEM property of RBC after coating of polymer on stent

RBC Label	*Diameter D µm*	*Mean*	*D-X*	*Square (R)*	*Square Root*	*Standard Deviations SD*	*Standard Error*
1	6.1	3.68	2.42	5.8564	2.42	1.135677	0.548584
2	4.2		0.52	0.2704	0.52		
3	3.3		-0.38	0.1444	0.38		
4	3.2		-0.48	0.2304	0.48		
5	3.1		-0.58	0.3364	0.58		
6	2.2		-1.48	2.1904	1.48		

Table 3: Observation table RBC properties after polymer coated stent

S. No	*Properties*	*Observed value*	*Reference value*
1	Specific Gravity	0.9843	1.0971
2	Density	0.846	1.110 g/mL
3	viscosity	4.1	3.5 and 5.5 cP
4	Osmotic Pressure	6.3	7.7 atm
5	pH for RBC	6.1	6.3–7.9
6	Erythrocyte sedimentation rate (ESR)	11	15 mm/hr

RBC Properties

Erythrocyte sedimentation rate (ESR) via autoanalyser (REMI), specific gravity, density, osmotic pressure, and pH for red blood cells were determined and results are shown in Table 3

CONCLUSION

The procedure for preparing the sample involves gathering 10 milliliters of blood in a test tube filled with ethylenediaminetetraacetic acid (EDTA) to stop blood coagulation, isolating the red blood cells using a centrifuge, and coating the coronary stent with polyethylene glycol PEG polymers using an R&D coating machine. Assessments of the polymeric-coated cardiac stent's biocompatibility and hemocompatibility were conducted using various evaluation criteria. CAD software has been used to help with the stent's modeling. According to the supplied catalog, the strut's thickness and width are calculated to be 0.065 mm and its length is 18 mm. The histology of RBC in an isolated sample (polymer coated on stent) found at 2000 Rx was examined using a motic microscope. Using a UV-visible spectrophotometer set to 414 wave length, a 10µg/ml solution of RBC in distilled water was scanned at 200–500 nm to measure the UV absorption maximum. The absorbance was found to be 0.8312 nm. An FTIR analysis of RBC reveals absorptions that include bending and stretching vibrations. Peak Position was discovered at wave numbers 3661.76, 1684.62, 1547.98, 1472.07, 1278.06, and 841.98. When the surface morphology of RBC was examined using scanning electron microscopy (SEM), it was discovered 6.1 µm, 4.2 µm, 3.3 µm, 3.2 µm, 3.1 µm, and 2.2 µm are the diameters. The found standard error was 0.548584. A high anti-restenotic performance and greater safety compared to the current polymer in terms of inducing inflammation in coronary artery walls have been noted for the PEG-coated stent in related RBC. The usage of this polymeric coated stent over a conventional polymeric stent may benefit in the long run from these findings. Further research is necessary to validate this promise, though. All things considered; a genuinely biocompatible stent may be achieved by addressing the fundamental lack of bio integration more directly through the several stent design advancements now under research.

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