大気圧非平衡プラズマを用いた糖鎖機能理解の深化とその利用

Understanding and application of the biological function of the glycosylation by through the low-temperature atmospheric pressure plasma technology

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Pathology describes the disease onset and progression as alteration and decay on homeostasis. Likewise, our earlier researches have been trying to link the change of glycosylation patterns with altered homeostasis and carcinogenesis [1]. Indeed, we have investigated the fluctuation of the multimeric glycoproteins in serum and succeeded to found out that glycan structures on M2BP altered with the progression of liver fibrosis [2, 3]. In this respect, it is a noteworthy fact that carbohydrate chains contribute to protein stability (proteostasis) through the dispersion or aggregation at the molecular level.

In research for plasma medical science, we first started to use the introduced low-temperature atmospheric-pressure plasma (LT-AP) technology by Dr. Sakakita as a method to deliver charge to proteins. We found that plasma treatment induced protein aggregations, and we extended this technology to hemostasis with minimal invasiveness, which is blood coagulation with plasma so far.

From 2012 to 2017, we participated in the interdisciplinary research project "Plasma Medical Science," which Prof. Masaru Hori at Nagoya University was a convenor for the project. There, we have clarified the scheme of hemostasis on the use of our developed mild plasma technology [4]. Moreover, we clearly showed that the action points for bleeding control by our plasma equipment were fundamentally different from bleeding the conventional Argon Plasma Coagulation (APC) [5]. APC intends to burn stromal tissue through electrocoagulation, the same as the other equipment such as the high-frequency electric coagulation (HFEC) and laser coagulation device. On the other hand, our advanced plasma equipment stops bleeding through the formed blood coagulation carried out by the plasma-induced protein aggregation(Fig. 1) [6-8]. Indeed, according to an earlier clinical study using APC, the point of action by APC is the same as it by HFEC and laser rather than our plasma medical equipment [9].

The most important finding for plasma hemostasis is that plasma can convert red blood cells, albumin, and immunoglobulins into coagulated blood (Fig. 2) [7, 10]. Blood clotting physiologically comes from the action of platelets and clotting proteins, and they play an indispensable role in forming and keeping clotting status. On the other hand, albumin and erythrocytes do not take part in the generation of coagulated materials that plug the ruptured site in the blood vessels. However, plasma technology turns red blood cells, which occupy around 40-50% of the volume of blood, and albumin and immunoglobulins, which make up more than 80% of plasma proteins by weight, into the coating materials to stop bleeding. This phenomenon discovered in plasma medical science has become a principle now for plasma hemostatic device as IEC60601-2-76.

My research career had begun with the discovery of a cancer-associated glycan that appears in gastric cancer and a sialyltransferase gene that synthesizes STn antigen [11], proceeding to drug delivery technology using glycan functions and development of glycobiomarkers [2, 12-15]. Now, our research is in the new stage where we can try to modify the biological roles of glycosylation by changing electric statues of proteins and tissues using plasma technology because we have already reached a stage being able to apply plasma technology for the alternating pathophysiological condition. In the symposium, we would like to introduce and discuss this new area that combines plasma science with glycobiology.

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