POSTER SESSION (NEW TECHNOLOGY 1)

New Technology 1

P1-039 RAPID MEASUREMENT SYSTEM OF HEMOGLOBIN FOR EVALUATION OF HEMOLYSIS IN ARTIFICIAL ORGANS
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Background: The hemolytic character is important characters in the blood contacting artificial organs. Present methods that evaluate the hemolysis in artificial organs employ circulation of blood and measurement of free hemoglobin. Cyanmethemoglobin method widely used to measure hemoglobin. Hemoglobin changes to cyanmethemoglobin react with potassium cyanide (KCN), and then absorbance measures with absorption meter. But KCN is high toxicity and this test needs at least 3 min for one sample. In this study, chemical luminescence technique applies to measure hemoglobin concentration and a new method was developed to measure it faster than old methods with high sensitivity.

Methods: The chemical reaction of Lumilum and O2 were catalyzed by the Fe complex as hemoglobin and this reaction generates 450nm photon emission. The photon emission can be detected by photon multiplier tube. Hemoglobin solutions (0 μg/dl to 100 μg/dl in plasma) were added to a mixture of Lumilum and H2O2 (source of O2) and the photon counts were measured at each concentration of hemoglobin for 20 seconds. Hemoglobin concentration compared with photon emission speed.

Results: The higher concentration of hemoglobin induced, the higher photon emission speed observed. The sensitivity of hemoglobin was 9.5 x 10^-5 mg/dl. This method can rapidly evaluate the hemoglobin concentration with high sensitivity. Small measurement system with UV photodiode is developing for easier measurement on bedside use.

P1-040 ENCLOSURE OF ISLET IN ULTRA-THIN LAYER-BY-LAYER MEMBRANE WITH ANTI-THROMBOGENIC PROPERTY
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A bioartificial pancreas, that is, transplantation of islets of Langerhans (islets) which are enclosed in a semi-permeable membrane, has been proposed as a safe and effective method to treat insulin-dependent diabetes mellitus. Since the islets are isolated from the host immune system by a semi-permeable membrane, they can survive and thus control glucose metabolism for a long period. However, some serious issues are still remaining to be solved, one is increase of total volume of the implant, which leads to the limitation of transplantation sites. Another is the side effect after transplantation such as inflammatory response and thrombosis. Therefore, new methods for preparation of the bioartificial pancreas have been required. Here we proposed a novel method to encapsulate islets with an ultra-thin membrane and to immobilize fibrinolytic protein, urokinase to the membrane using poly(ethylene glycol)-conjugated phospholipid and layer-by-layer membranes of proteins. After incorporation of PEG-lipid carrying a biotin group into the surface of islet, layer-by-layer membranes composed of streptavidin and biotin-conjugated BSA could be formed on the islets surface with nanometer in thickness. No practical volume increase in islets was observed after microencapsulation. We confirmed the insulin release function in response to the glucose stimulation and fibrinolytic property for the urokinase-immobilized bioartificial pancreas.

P1-041 SURFACE MODIFICATION OF ISLETS USING POLY (VINYL ALCOHOL) DERIVATIVE
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Microencapsulation of islets with semi-permeable membrane has been proposed as an effective method to transplant islets without the need for immunosuppressive therapy. It has been demonstrated that microcapsules effectively isolate islets from the host immune system and insure their long term survival without administration of immunosuppressive drugs. Increasing of total volume of the implant, however, limits the selection of transplantation sites. Here, we proposed a new strategy to solve these problems. Islets are enclosed with a very thin polymer membrane and immobilization of urokinase to dissolve blood clots or complement regulator (soluble complement receptor 1 (sCR1)) to regulate the acute rejection.

We synthesized a poly(vinyl alcohol) (PVA) derivative carrying carboxyl groups, thiol groups and alkyl chains. When the PVA derivative is added to cell suspension, this PVA layer spontaneously forms on cell surface via hydrophobic interaction between side alkyl chains and the cell membrane. Thiol groups of the PVA which can be used to immobilize various substances on the cell surface through the thiol/maleimide reaction. Cells with the PVA derivative were mixed with Uroki-nase modified with maleimide. Urokinase was immobilized on the cell surface. No practical volume increase in cells was observed after surface modification, and cell viability after modification was not decreased.

P1-042 A NOVEL NETWORK USER INTERFACE SYSTEM FOR TELE-MENTORING IN LAPAROSCOPIC SURGERY ROBOT
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Background: Many novel application concepts in the development and clinical application of laparoscopic surgery robot have been proposed, and tele-mentoring is one of important concepts. The authors propose a novel network interface enabling multi-user concurrent access on motion logging from a real-time surgery scene or past surgery records through a central database server.

Methods: The system is composed of remote clients installed in remotely located surgeon’s PC, a data relay client in surgery robot system and a central database server. All the motion data from the surgery robot located at the surgery site and motion input devices such as haptic interface devices at each participant’s site, are captured, logged and shared through the central server in real-time manner for tele-teleoperation or in a replay mode for past data review. The client interface screen displays all motion data drawn in a form of virtual laparoscopic tools overlaid on the actual laparoscopic video image, so the users can see all the motions of the laparoscopic tools of the actual surgery site and of other advisory participants at the same time.

Results: The implemented system showed satisfactory function. It is believed that the system could have one of basic tools for better training and education of novel surgical technologies in artificial organ implantation.
P1-043  Position Control in an Event Control Based Telesurgery Robot Using Adaptive Fuzzy PID Controller

Keywords: Event control; Telesurgery; Artificial pancreas; Artificial myocardium


Background: In the surgical field, artificial pancreas is being studied as a method to control blood glucose level, indicating its great clinical value in patients with surgery.

Methods: We evaluated the performance of the prototype artificial pancreas in patients undergoing hepato-biliary-pancreatic surgery. The artificial pancreas consisted of an artificial pancreas and an artificial myocardium. The artificial pancreas was controlled by the artificial myocardium, which was controlled by an artificial pancreas.

Results: The artificial pancreas was successfully controlled by the artificial myocardium, indicating its great clinical value in patients with surgery.

Conclusions: The artificial pancreas is a promising method to control blood glucose level in patients with surgery.

P1-044  PRELIMINARY STUDY ON AN OPTIMAL REGULATION OF THE ARTIFICIAL MYOCARDIUM BASED UPON THE FIBROUS CONTROL METHODOLOGY OF SHAPE MEMORY ALLOY


Background: The purpose of this study was to construct the control methodology of functional assistance by an artificial myocardium using the integrative small mechanical elements composed of shape memory alloy fibers.

Methods: The authors fabricated the prototype artificial myocardial assist unit composed of the sophisticated shape memory alloy fiber (Biometal), the diameter of which was 100 microns, and examined the mechanical response by using PID (Proportional-Integral-Derivative) control method in each unit. Prior to the evaluation of dynamic characteristics, the relationship between strain and electric resistance and also the initial response of each unit were obtained. The component for the PID control was designed in order to regulate the myocardial contraction function, which consisted of an originally-designed RSC microcomputer with the input of displacement, and its output signal was controlled by pulse wave modulation method.

Results: The optimal PID parameters were confirmed and the fibrous displacement was successfully regulated under the different heart beat transfer conditions simulating internal body temperature as well as bias tensile loading. Then it was indicated that this control theory might be applied for more sophisticated ventricular passive or active restraint by the artificial myocardium on physiological demand.

P1-045  Chronic recording of Visually evoked cortical potentials for long-term evaluation of visual prostheses

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Background: Confirming long-term safety and functionality is the key issue in developing artificial organs. We have been developing retinal prostheses and evaluation method of long-term functionality of prostheses is of prime necessity.

Aim: To develop a method to confirm long-term functionality of retinal prostheses in vivo.

Methods: A custom-made measurement electrode was implanted onto the visual cortex of rabbits. The external form of the electrode was a 17.5mm-long screw with a diameter of 2.5mm. Two or four platinum ball with a diameter of 0.7mm were attached at the tip of the screw and functioned as measurement electrodes. Electrodes were implanted approximately at the incus anterior to the lambda and 6mm lateral to the median. Flash visually evoked cortical potentials (VEPs) were recorded periodically for 48 weeks. General anesthesia was maintained by ventilation with oxygen and isofluorane (1.0-2.5%) during recordings. We controlled the anesthetic depth by monitoring isofluorane concentration in the expiration. Impedances of electrodes were also recorded periodically.

Results: Amplitudes and waveforms of VEPs were stable for 48 weeks under the condition that concentration of isofluorane in the expiration was constant. Impedances of electrodes tended to decrease during the first two weeks after implantation and became stable thereafter. Cortical potentials evoked by electrical stimulation to the retina could also be recorded by the recording electrode.

Conclusion: It is possible to record VEPs of rabbits chronically by introducing our recording electrode. We will try a long-term recording of electrically evoked potentials in the next step.

P1-046  Perioperative glycemic control by using closed-loop system, artificial pancreas, in patients undergoing hepato-biliary-pancreatic surgery

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Background and aims: Hyperglycemia induced by the surgical stress often dysregulates liver metabolism and immune response resulting in the impaired postoperative recovery. The purpose of the present study was to evaluate usefulness of artificial pancreas, STG-22 (Nihonkai Inc., Tokyo) in control of the perioperative blood glucose levels during surgery. Case study 1 (hepatic resection): A 65-year-old man with the past medical history of diabetes mellitus underwent partial liver resection for hepatocellular carcinoma with Child-Pugh B Grade. Case study 2 (pancreatic resection): The patient with diabetes mellitus was a seventy-four year-old male with the past medical history of radical nephrectomy for left renal cell carcinoma. On computed tomography a well enhanced round mass was situated at the head and the tail of the pancreas. Pylorus-preserving pancreaticoduodenectomy and pancreatic headectomy were performed synchronously for pancreatic metastasis of renal cell carcinoma. Perioperative glucose level was well controlled in both cases, although each patient had a medical history of diabetes mellitus. Conclusion: In perioperative hyperglycemic state, the closed-loop system STG-22, artificial pancreas, safely achieved a strict control of blood glucose level, indicating its great clinical value in patients with surgery.