Medical device retrieval programme: An Indian initiative

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Statement of Purpose: The examination of a medical device following long term implantation in the human body assumes importance today with the regular use of different types of implants[1] and increase in reports of device failure. Clinical trials conducted prior to release of a device for public use are of short term and provide information on the clinical performance of the device in humans for a short term only. However, material surface and bulk properties change with time in the biological environment followed by changes in adjacent tissue[2] resulting in clinical failure and necessity of revision surgery. Based on these facts, an implant retrieval programme was devised, the main objective of which was to collect medical devices removed from the patient at revision surgery and to investigate the physico-chemical characterization of the retrieved components of the device as well as to study the cellular and molecular mechanisms at the tissue-implant interface.

Methods: The retrieval analysis was planned based on ISO 12891 guidelines. An 'implant retrieval form' was prepared and dispatched to the clinicians prior to revision surgeries to fill in the relevant patient history and implant details. The various implants collected include orthopedic implants like hip and knee joints, fracture plates and nails, hydroxyapatite grafts, cardiac implants like mechanical and bio prosthetic heart valves, annuloplasty rings and vascular grafts. The implants along with the peri-implant tissue were collected in 10% neutral buffered formalin and assigned a unique identification code. Macroscopic observations like signs of corrosion or mechanical failure of implants, necrosis, thrombosis or pannus formation were recorded using macropath photography system. The peri-implant tissue was removed from the implant, grossed, processed for paraffin embedding and Haematoxylin and Eosin (H&E) staining. After tissue removal all implants were cleaned and dried at room temperature for further physico-chemical characterization. The cellular response to orthopedic implants was studied in the peri implant tissue by Hematoxylin Eosin(HE) staining and specific localization of immune cells like macrophages, endothelial cells, mast cells, immune modulators like mast cell tryptase, chymase, receptor molecules like Toll like receptor-4 (TLR-4) and Hypoxia inducible factor(HIF) were carried out by Immunohistochemical studies using specific antibodies. The presence of TLR-4 and hypoxic environment at tissue- material interface around stainless steel fracture plates was further studied by Real time PCR and PCR Array studies . The presence of corrosion debri in the peri prosthetic tissue was detected by Inductively Coupled Plasma-Absorption Emission Spectrocopy (ICP-AES) and Environmental Scanning Electron Microscopy-Elemental Distribution X-Ray Analysis (ESEM-EDAX) and semi-quantitatively graded from HE stained sections. The retrieved metallic implants were subjected to surface examination, corrosion analysis and mechanical failure assessment. The cellular ingrowth, thrombus and pannus formation in cardiac implants was studied by HE staining of resin embedded sections. The occurrence of calcification in the heart valves was tested by von-Kossa staining and confirmed by micro-CT studies.

Results: Orthopedic plates and screws were found to definitely undergo different types of physico-chemical changes like fatigue, pitting following long term residence in the body. These changes lead to release of material debri which was found in surrounding tissue by microscopy as well as by ESEM-EDAX and ICP-AES analysis. The continuous presence of foreign bodies in the tissue elicited chronic inflammation as evident by the presence of macrophages, activated endothelial cells, TLR-4 and HIF adjacent to metallic debri. The elemental composition of released metal debri was comprised of Nickel, chromium and Titanium. The role of mast cells in eliciting chronic inflammation adjacent to metal implants and the probable role of TLR-4 mediated recognition of wear debri was revealed through these studies. The histological features observed in sewing rings of different types of heart valves were similar in all valves irrespective of type and make. Mild, moderate and heavy calcification was observed in the sewing rings along with the constant long term presence of macrophages.

Conclusions: This extensive study has revealed the synergistic role of physico-chemical properties and biological milieu in determining the molecular biocompatibility of an implant within the host. The execution of the project has paved the ground work for the establishment of a National Medical Device Retrieval Programme in the research group's Nation where there is complete absence of any structured data collection system on the *in vivo* fate of prosthesis.

References:

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