DEVELOPMENT AND MODIFICATION OF BIOSTABLE SUTURES

by

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CERTIFICATE

THIS is to certify that the thesis entitled DEVELOPMENT AND MODIFICATION OF BIOSTABLE SUTURES being submitted by MR. PERMOD KUMAR TYAGI to the INDIAN INSTITUTE OF TECHNOLOGY, DELHI for the award of DOCTOR OF PHILOSOPHY, is a record of bonafide research work carried out by him. Mr. Tyagi has worked under my guidance and supervision and has fulfilled the requirements for the submission of the thesis.

The results contained in this thesis have not been submitted in part or in full, to any other University or Institute for the award of any degree or diploma.

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DEDICATED

TO

MY

PARENTS

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ABSTRACT

The present work was devoted towords the development and modification of polymers for nonabsorbable suture application. In the first part of the thesis medical grade black braided silk and pure mulberry twisted silk sutures were grafted with polymethacrylic acid (MAA)/2-hydroxyethylmethacrylate (HEMA) by simultaneous gamma irradiation technique using Co^{60} as a radiation source. Effect of dose rate, total dose, solvent composition and monomer concentration, on the grafting of MAA/HEMA onto silk sutures, was studied. Grafting increased with total dose and monomer concentration. However, at lower dose rates the grafting was found to be higher. Maximum grafting was observed in 1.1 water:methanol solvent mixture. Radiation induced grafting of (HEMA) onto monofilament polypropylene suture has also been discussed in this part of the thesis. The influence of various parameters such as dose rate, total dose, monomer concentration and solvents on the grafting, was examined. The results were in agreement as in the case of grafting of silk sutures with MAA/HEMA. In this case maximum grafting was observed in chlorobenzene at a constant total dose and dose rate.

Poly N-vinyl pyrrolidone-iodine (PVP-I) blended polypropylene (PP) sutures were also developed from food grade PP and PVP-I complex in an extruder at 220°C.

The second part of the present work was devoted towards the characterization of unmodified and modified silk and polypropylene sutures. In case of silk sutures, diameter and density increased with an increase in the percent grafting of MAA/HEMA. In dry state, tensile strength and breaking load of straight and knotted silk sutures increased with an increase in percent grafting of MAA/HEMA only upto 23% graft level beyond which they decreased. However, percent elongation at break decreased continuously with an increase in percent grafting. In wet state, tensile strength and breaking load of various silk sutures were found low as compare to the dry state. However, in wet state percent elongation at break increased continuously. Crystallinity decreased with an increase in percent grafting of MAA/HEMA on to silk sutures. Thermal stability of silk sutures increased after grafting with MAA/HEMA. Surface roughness of silk sutures also increased with an increase in percent grafting of MAA/HEMA.

Characterization of unmodified and HEMA grafted polypropylene sutures was carried out using similar techniques and have also included in the second part of this work. Diameter, density and percent swelling were found to be increased with percent grafting of HEMA onto PP sutures. Tensile strength and breaking load of straight and knotted PP sutures increased with an increase in percent grafting

only upto 17% graft level. However, percent elongation at break decreased continuously with increased percent grafting of HEMA. HEMA grafted PP sutures gave intense blue colour with methylene blue and a peak of hydroxyl group at 3400cm^{-1} in infrared spectrum. X-ray crystallinity also decreased with increased percent grafting of HEMA onto PP sutures. Characterization of PVP-I blended PP sutures were also carried out and have been reported in the second part of this work. Density of PVP-I blended PP sutures increased with an increase in the percentage of PVP-I content. Tensile strength and breaking load increased with an increase in the PVP-I concentration only upto 2%. However, percent elongation at break continuously decreased with PVP-I content. Melting point of PVP-I blended PP sutures was found to be high as compare to the original PP sutures. However, heat of fusion of various PVP-I blended PP suture were low as compare to the original PP suture. Crystallinity of PP decreased with an increase in the PVP-I concentration in PP polymer. Surface of PVP-I blended PP suture was also found to be rough as compare to the original PP suture.

The third part of the work was devoted towards immobiliztion/absorption of 8-hydryxyquinoline (8HQ), an antimicrobial drug, onto various MAA/HEMA grafted twisted silk and monofilament PP sutures: The release in invitro and

antimicrobial activity of 8HQ immobilized silk sutures have also been discussed in this part. It was found that immobilized 8HQ retained its activity against microorganism and the release was sustained upto about 32 days from MAA grafted twisted silk sutures and 8-9 days from HEMA grafted twisted silk sutures. However, in case of HEMA grafted PP sutures, the release was sustained only for about 4-5 days.

In the fourth part of the work, tissue and blood compatibility of various unmodified and modified silk and polypropylene sutures were evaluated and were found to be improved after grafting with MAA/HEMA. Tissue and blood compatibility of PVP-I blended PP sutures were found to be improved as compare to the original PP sutures. The role of various unmodified and modified sutures in the development of infection in wounds against S.aureus was also evaluated. No infection was observed in 8HQ immobilized/absorbed silk and PP and PVP-I blended polypropylene sutures upto the 4th day of post implantation.

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CHAPTER-VI: SUMMARY AND SCOPE FOR FUTURE WORK