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Design and fabrication of a novel meniscal prosthesis

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Statement of the Problem: The motivation for the design of the novel meniscal implant was based on the collagen fibre orientation in the native meniscus, which is the dominant component of the native meniscus. The architecture of the meniscus is such that the collagen fibre bundles wound circumferentially, and are responsible for the complex multifaceted load bearing nature; while a small number of radially orientated collagen fibres function like a fastener for the circumferential fibres, providing support and preventing them from splitting under loading conditions. Polymeric composite biomaterials are both anisotropic and heterogeneous which are the properties of the natural meniscus. A combination of the circumferential and radial reinforced fibres in a matrix is therefore anticipated to produce an enhanced final outcome. The development and fabrication of such an artificial composite structure with both circumferential and radial oriented fibres is complicated and is therefore a challenge.

Materials & Methods: Bionate PCU 80A and 90A pellets, and Dyneema Purity® UG fibres. The prostheses were fabricated in a two-stage injection moulding process. A mini bench-top injection moulding machine was designed and fabricated for this purpose.

Findings: With some moulding challenges overcome, the process proved to be a successful means of producing the meniscal composite prostheses with reinforcement fibres orientated both circumferentially and radially in the PCU matrix.

Conclusion: A manually operated injection moulding machine has been designed and fabricated for manufacturing the prostheses. Having overcome the limitations of the manual equipment, it could be said that the method if revised and automated could be a feasible means by which the prostheses can be produced for clinical applications.

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Conducting polymer based composites as scaffold for tissue engineering application

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Stimuli-responsive polymers are special class of polymeric materials which can respond to even very slight changes in temperature, pH, light, and ionic strength, have been widely utilized in tissue engineering, drug delivery systems and sensors. Temperature change is a widely observed phenomenon in the physiological systems. Temperature-sensitive materials have attracted significantly owing their ability of intelligent response to temperature changes. The most challenging aspect in the temperature controlled cell adhesion is the development and design of 3D scaffolds which should provide a suitable and proper environment for easy attachment, proliferation, differentiation and detachment of cells. Poly (N-isopropylacrylamide) (PNIPAM) is a well-known and studied thermo responsive polymer. It exhibits a reversible phase transition between hydrophilicity and hydrophobicity because of intermolecular and intramolecular hydrogen bonding. Based on this mechanism, the poly (N-isopropylacylamide) based matrices could act as the controllable temperature-responsive bio-switches for biomedical and biotechnology applications. On the other hand, conducting polymers especially polyaniline has received much attention in recent past because of good processability, fast charge-discharge and biocompatibility. When fibroblast cells were seeded on the nanofibers surface, the PANI-PNIPAm composite nanofibers exhibited highest cell growth and %live of around 98% indicating very good biocompatibility and possible use of these nanofibers as scaffold for the tissue engineering application recognition.

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