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Developing 17-β-estradiol releasing electrospun polyurethane scaffolds for pelvic floor repair

Sarah Shafaat[1], Sheila MacNeil[1], Sabiniano Roman Regureos[1], Naside Mangir[1,2] and Christopher R Chapple[2]
[1]University of Sheffield, UK
[2]Royal Hallamshire Hospital, UK

Statement of the Problem: Pelvic Organ Prolapse (POP) and Stress Urinary Incontinence (SUI) are two urogynecological diseases that affect 40-50% of postmenopausal women worldwide. Surgical interventions for these disorders require Polypropylene (PPL) mesh placement to support the pelvic floor that can lead to severe complications in some patients. The need for synthetic materials more suited for use in pelvic floor repair is widely accepted. This study aims at developing an electrospun 17-β-estradiol releasing polyurethane scaffold that not only mimics the structural design of native human fascia but can also stimulate new extracellular matrix production and angiogenesis.

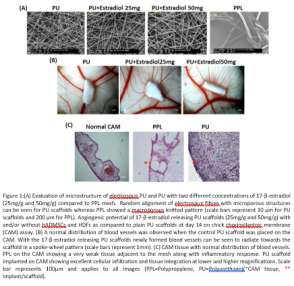

Figure 1:(A) Evaluation of microstructure of electrospun PU and PU with two different concentrations of 17-β-estradiol (25mg/g and 50mg/g) compared to PPL mesh. Random alignment of electrospun fibres with microporous structures can be seen for PU scaffolds whereas PPL showed a macroporous knitted pattern (scale bars represent 30 μm for PU scaffolds and 200 μm for PPL). Angiogenic potential of 17-β-estradiol releasing PU scaffolds (25mg/g and 50mg/g) with and/or without hADMSCs and HDFs as compared to plain PU scaffolds at day 14 on chick chorioallantoic membrane (CAM) assay. (B) A normal distribution of blood vessels was observed when the control PU scaffold was placed on the CAM. With the 17-β-estradiol releasing PU scaffolds newly formed blood vessels can be seen to radiate towards the scaffold in a spoke-wheel pattern (scale bars represent 1mm). (C) CAM tissue with normal distribution of blood vessels. PPL on the CAM showing a very weak tissue adjacent to the mesh along with inflammatory response. PU scaffold implanted on CAM showing excellent cellular infiltration and tissue integration at lower and higher magnifications. Scale bar represents 100μm and applies to all images (PPL=Polypropylene, PU=Polyurethane, *CAM tissue, ** implant/scaffold).

Method: Polyurethane (PU) scaffolds with and/or without 17-β-estradiol (25 mg/g and 50 mg/g) were prepared by blend electrospinning and mechanical properties of constructed scaffolds were assessed by uniaxial cyclic and non-cyclic testing. Water Contact Angle (WCA) measurements showed the hydrophilicity of the scaffolds. The viability and extracellular matrix production of cultured human adipose derived mesenchymal stem cells (hADMSCs) cultured on 17-β-estradiol releasing PU scaffolds was evaluated. The angiogenic potential of estradiol releasing scaffolds was evaluated using an ex ovo chick Chorio Allantoic Membrane (CAM) assay.

Findings: The inclusion of 17-β-estradiol in PU scaffolds did not change the ultrastructure rather it significantly increased the UTS (Ultimate Tensile Strength) of scaffolds. Estradiol was released gradually from the scaffolds over a period of 3 months and hADMSCs on estradiol-releasing PU scaffolds showed more ECM (Extracellular Matrix) production. The CAM assay showed a significantly higher angiogenic potential of estradiol-releasing PU scaffolds and histological examination showed appropriate cellular infiltration and improved tissue integration for all electrospun scaffolds compared to PPL.

Conclusion: We demonstrate the angiogenic potential of estradiol-releasing PU scaffolds with appropriate strength and elasticity desirable to support the pelvic floor.

Biography

Sarah Shafaat has her expertise in the area of developing suitable biomaterials for use in female pelvic floor regeneration. In 2017 she has completed her Masters in Biomaterials and Regenerative from The University of Sheffield, UK.

sarah.shafaat@gmail.com

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