



**2025 Biomedical Research Award
Dr. Rishma Shah, Indiana University**

Biography

Dr. Rishma Shah is a tenured Associate Professor at Indiana University School of Dentistry (IUSD). In addition to working in the Department of Orthodontics and Oral Facial Genetics, she is a member of Riley Children's Health Craniofacial Anomalies team and a member of the Indiana Center for Musculoskeletal Health in the IU School of Medicine.

Dr. Shah completed her BDS with honors (DDS equivalent) at the United Medical and Dental Schools of Guy's and St. Thomas' Hospitals, London. She received her MS in Orthodontics with distinction and her PhD in Biomaterials and Tissue Engineering from the University of London, England. She has also completed Fellowships in Dental Surgery and in Orthodontics at the Royal College of Surgeons of England. Dr. Shah is trained and has experience in the management of complex craniofacial and interdisciplinary cases. Her research complements her clinical interests.

Project Synopsis: *“Connecting Muscle and Bone: Engineering the Entesis”*

Craniofacial deformity is debilitating, negatively affecting one's quality of life and the ability to integrate well into society. Such deformity may be congenital (e.g. craniofacial microsomia), or following trauma or surgery for disease removal. It has been shown surgical reconstruction increases attractiveness and decreases negative facial perception, as judged by the general public. Unfortunately, large volumetric muscle defects are very difficult to manage, with current methods of autologous grafting or use of fillers or prostheses fraught with limitations, including tissue mismatch and resorption. There is an urgent need to help our patients by investigating and identifying alternative therapies without the limitations of current approaches.

Tissue engineering is an interdisciplinary field, which aims to provide substitute tissues and organs identical to that missing or defective. The provision of identical tissue allows for better integration and function, and a more permanent solution to those currently in place. Our long-term goal is permanent restoration of craniofacial soft tissue defects using precision-engineered autologous craniofacial skeletal muscle tissue. Our lab is at the forefront of craniofacial muscle regeneration and we have combined masseter muscle-derived cell populations with scaffolds, growth factors, and mechanical loading in an attempt to produce the ideal tissue for implantation. We have already demonstrated the potential to form muscle tissue expressing factors found only in the craniofacial muscles, and our most recent work found expression of genes associated with tendon tissue. The ability to have muscle tissue supported by tendinous tissue is highly desirable to provide the ability to connect muscle with bone when implanted. This connectivity between muscle and bone is critical for musculoskeletal motion.

Our proposed study objective is to further investigate the potential for engineering masseter

muscle with contiguous tendon tissue. Our central hypothesis is that successful engineering of craniofacial muscle and contiguous tendon tissue depend on the interaction between craniofacial muscle-derived cells, 3D biomimetic scaffolds, and mechanical loading. Two independent yet related specific aims will test our hypothesis: Aim 1 will develop and test biomimetic scaffolds for craniofacial muscle and tendon regeneration, and Aim 2 will investigate the impact of mechanical loading on muscle and tendon formation. We will use histological methods, reverse-transcriptase polymerase chain reaction (RT-PCR), enzyme-linked immunosorbent assays (ELISA), and western blots to test for markers of muscle and tendon formation and extracellular matrix turnover.

We anticipate masseter muscle-derived cells seeded within carefully designed and produced hybrid collagen-resin scaffolds will produce muscle and contiguous tendon tissues. We expect muscle markers will be consistent with those found in native masseter muscle. We also anticipate that mechanical loading will lead to superior tissue formation compared to non-loaded scaffolds.

How Orthodontic Education Will Benefit from the Award

The orthodontist is a key member of the interprofessional team managing patients with craniofacial anomalies and defects. Our proposed novel study will provide valuable information on the potential of tissue engineering approaches for use in the management of patients presenting with such craniofacial problems and opening up the possibility of alternative treatment options. In addition, the study outcomes will provide new knowledge on craniofacial muscle regeneration, which has been poorly studied thus far.

Why the Foundation is Important to the Project

The Foundation is an important advocate of the project and its long-term implications for patients presenting with craniofacial anomalies/defects. The funding provided by the Foundation is essential for the generation of preliminary data to support future funding applications. Furthermore, the new knowledge learned from this project has potential to support development of a novel, innovative, and possibly more effective therapy to manage soft tissue defects of the craniofacial region.

How Foundation Funding has Advanced my Career

I am very grateful to the Foundation for the award of this funding. Prior awards from the Foundation have helped protect my research time and allowed me to generate preliminary data to support grant funding applications. Through the support of the Foundation since 2020, I have secured >\$2m in research funding, including an R01 award from the NIDCR. I plan to utilize the data generated from this project to support a new R01 application to the NIDCR. As a tenured Associate Professor, the award of research funding from institutions, such as the NIH/NIDCR, is critical for advancing my career as a clinician-scientist-educator in the field of orthodontics.