

Master's Thesis

in collaboration with
IGTE and IMAT

The impact of Relaxin on Ligament and Joint Modeling in Multibody Dynamics

Description

Musculoskeletal (MSK) modeling and multibody system (MBS) dynamics have made significant advancements, yet their application in clinical decision-making remains limited. A critical gap in current models is the lack of consideration for hormonal modulation of musculoskeletal tissues, particularly the role of relaxin, a peptide hormone known to influence ligament laxity, joint stability, and tissue remodeling.

Relaxin's effects are especially pronounced in sex-specific and life-stage-specific scenarios, such as pregnancy, elite athletics, and hormonal therapies. Recent studies highlight its impact on ligament and joint mechanics, particularly in the knee and elbow joints, where it modulates collagen turnover, alters tissue stiffness, and affects joint stability. For example, elevated relaxin levels have been linked to increased anterior cruciate ligament (ACL) laxity in the knee and trapeziometacarpal joint instability in the hand, both of which can predispose individuals to injury or degenerative conditions.

This master's thesis will focus on integrating relaxin's biomechanical effects into MSK models, with a specific emphasis on knee and elbow joint mechanics. The goal is to develop a computational framework that accounts for hormone-dependent tissue properties, enabling more accurate predictions of joint stability, injury risk, and therapeutic outcomes in both clinical and athletic contexts. The work will involve a detailed review of relaxin's biological and mechanical effects on ligaments, tendons, and cartilage, followed by the implementation of these effects in MSK simulations.

Tasks

- Study relaxin's biological and mechanical effects on musculoskeletal tissues
- Select or adapt an existing MSK model
- Scale ligament parameters: stiffness, damping, and failure thresholds based on relaxin levels

Requirements

- Interest in biomechanics, musculoskeletal modeling, and multibody dynamics
- Basic knowledge in programming

Contacts

Institute of Mechanics - ifm@tugraz.at
Gian Marco Melito - gmelito@tugraz.at

