Failure and Injury Locus of Anterior Cruciate Ligament: A Finite Element Study

Background: Anterior cruciate ligament (ACL) tears are common injuries occurring upwards of 250,000 times annually only in the U.S. These injuries create an annual billion dollar expense. It is important to understand these injury mechanisms as these injuries continue to be one of the largest problems in orthopedic sports medicine. Improved understanding of the injury mechanisms may improve prevention, rehabilitation and surgical procedures.

Objective: This study used a 3-Dimensional finite element (FE) knee joint model to investigate the combinations of movement, which cause ACL injury.

Method: Digital bone structures were created from magnetic resonance images (MRI). Ligament bundles were modeled based on the origins and insertion sites determined from MRI. Bone was modeled as rigid, and a transversely isotropic Mooney-Rivlin material was applied to the ligament structures. This study incorporates a novel approach for developing bundle specific prestrain within 3-D ligament structures. The bundles were stretched from their zero load lengths to their reference lengths, producing a strain field mimicking the in vivo strain conditions of the ACL at full knee extension. A failure locus was created by performing multiple FE simulations of knee joint motion combinations until ACL failure.

Result: The relationship between knee joint orientation and ligament rupture was plotted providing a spectrum for the propensity of ACL injury based on knee joint orientations, known as a failure locus. The locus shows which combinations of internal/external femoral rotation and varus/valgus angle cause ACL failure. The results show the posterolateral bundle more susceptible to rupture than the anteromedial bundle in 17 of the 22 simulations. The results also show 45% less varus angle needed for ligament failure relative to valgus angle. The results highlight femoral external rotation as an important factor for ACL injury as it decreases the failure angle by an average of 23% compared to femoral internal rotation.

Conclusion: These results have various clinical applications. In sports where ACL injuries are prevalent, training programs can be adapted to address the avoidance of harmful knee orientations.

HIV Molecular Epidemiology in the Middle East and North Africa: Understanding the Virus Transmission Patterns

Background: Human Immunodeficiency Virus Type I (HIV-1) is characterized by a high genetic variability. The distribution of HIV-1 subtypes in a population can help track transmission patterns and the evolution of the epidemic. The Middle East and North Africa (MENA) continues to be perceived as a region with limited HIV epidemiological data, but recent research indicates that nascent HIV epidemics appear to be emerging among high-risk groups including injecting drug users (IDUs), men who have sex with men, and female sex workers.

Objective: To review all evidence on HIV-1 subtype distribution in MENA where there remain several gaps in the understanding of the HIV epidemic.

Methods: A comprehensive systematic review of all HIV-1 molecular epidemiology data in MENA was undertaken. Sources of data included 1) PubMed, 2) country-level reports and database including governmental and non-governmental organizations publications, and 3) international organizations reports and databases.

Results: In several countries such as Lebanon, Saudi Arabia, and Yemen, a very diverse distribution of HIV-1 subtypes was observed reflecting principally travel-related exogenous exposures. A trend of a dominant HIV-1 subtype was observed in few other settings and was often linked to HIV transmission within specific high-risk core groups such as subtype A and CRF35_AD among IDUs in Afghanistan, Iran, and Pakistan; and subtype C in heterosexual commercial sex networks in Djibouti and Somalia. Subtype B was predominant in Northern Algeria, Tunisia, and Morocco, but this appeared to reflect a mix of indigenous endemic transmission and exogenous exposures of West European and North American origin.

Conclusions: Multiple introductions of HIV-1 variants due to exogenous exposures of nationals seemed common to all MENA countries, as observed from the high diversity in subtypes or the high genetic divergence among any specific subtype even if predominant. This in part reflects the high population mobility in MENA. In several countries though, epidemic-type clustering of specific subtypes suggests established or nascent HIV epidemics among classic core risk groups for HIV infection. With overall weak surveillance systems in MENA, molecular investigations could help identify the emergence of hidden epidemics among high-risk groups. HIV prevention efforts must be prioritized for these groups.