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Feasibility Study of Accelerator-Based Boron Neutron Capture Synovectomy (BNCS) For Treating Rheumatoid Arthritis

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This study investigates the feasibility of Boron Neutron Capture Synovectomy (BNCS) as a targeted treatment for rheumatoid arthritis using accelerator-based neutron sources. BNCS offers a non-invasive alternative to surgery by delivering high-linear energy transfer (LET) radiation directly to diseased synovial tissue through the 10B(n,α)7Li reaction. A compact epithermal neutron beam was modeled using the 7Li(p,n)7Be reaction at 1.97 MeV, with an optimized moderator and reflector configuration. A detailed knee phantom was constructed, including tissue-equivalent layers such as skin, synovium, cartilage, and bone. Monte Carlo simulations were performed using MCNPX to estimate neutron interaction and dose deposition in the synovium under various boron concentrations. The results demonstrated efficient dose delivery to the target region with minimal exposure to surrounding healthy tissues. These findings support the potential clinical applicability of BNCS, highlighting its effectiveness, safety, and adaptability for treating joint conditions in an outpatient setting.

Technical Track

Student Competition

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