RADIATION-INDUCED SKELETAL MUSCLE INJURY: MECHANISMS AND THERAPEUTIC PERSPECTIVES

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Radiotherapy remains a cornerstone of cancer treatment. However, it often leads to unintended damage to adjacent healthy tissue, including skeletal muscle. Ionizing radiation induces oxidative stress and chronic inflammation, leading to impaired muscle regeneration and long-term loss of function. While adult skeletal muscle is generally considered resistant to low to moderate doses of ionizing radiation, higher doses can still cause significant damage. In contrast, developing skeletal muscle is highly sensitive to radiation, which makes radiotherapy in children particularly worrying as it can lead to muscle atrophy and permanent deficits in muscle function.

The main mechanisms underlying radiation-induced muscle damage include depletion and dysfunction of satellite cells, disruption of myogenic differentiation and defects in tissue remodeling. Irradiation also promotes fibrosis and vascular injury in the muscle microenvironment, further exacerbating the failure of regeneration. In addition, dysregulation of cytokine signaling pathways impairs the activation and differentiation of satellite cells, exacerbating the regeneration deficit.

Taken together, these pathological changes contribute to persistent muscle weakness, reduced mobility and lower quality of life in cancer survivors. Emerging evidence suggests that therapeutic agents such as melatonin and specific growth factors may help mitigate radiation-induced muscle damage by preserving satellite cell function and modulating oxidative and inflammatory responses.

A deeper understanding of the molecular and cellular basis of radiation-induced muscle injury is crucial for the development of targeted interventions. Multidisciplinary strategies could significantly improve functional recovery and overall outcomes in patients receiving radiotherapy.

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