Thermal Protection Strategies during ablation of Musculoskeletal Tumors

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Background and Significance

Although ablation of musculoskeletal tumors is a promising treatment strategy with expanding indications, the prevention and mitigation of surrounding tissue damage remains a persistent challenge requiring advanced thermal protection strategies. Here we evaluate the efficacy of current and emerging adjunctive thermal protection strategies for musculoskeletal tumors based on contemporary literature during the past decade from 2015 to 2025.

Methods

A comprehensive review of the literature was conducted, evaluating PubMed-indexed studies on thermal protection strategies during ablation of musculoskeletal tumors between 2015 and 2025. The search included systematic reviews, narrative reviews, clinical trials, and retrospective cohort studies. The techniques reviewed included hydrodissection, pneumodissection, direct skin protection, physical displacement, temperature modulation, neurophysiologic modulation, and biofeedback.

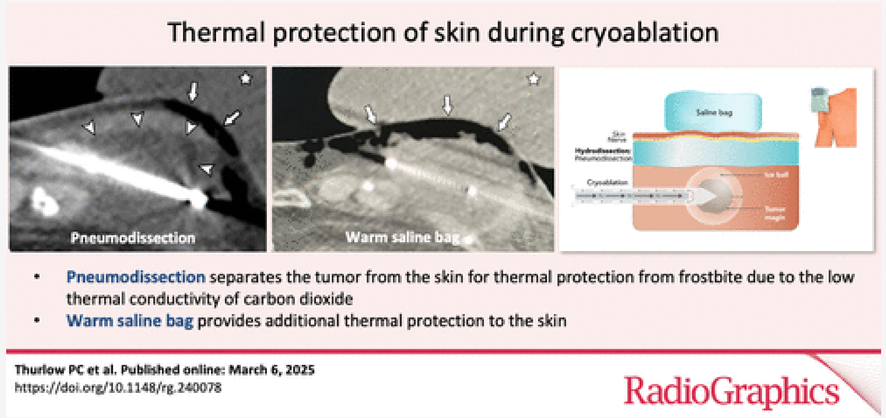
Passive Techniques

- **Temperature monitoring**
- **Neurophysiologic monitoring**
- **Biofeedback**

Active Techniques - Hydrodissection

Hydrodissection has rapidly become a standard of care to protect skin, nerves and bowel; recent promising advancements in hydrogel technology intend to improve tissue retention and insulation. Additionally, temperature modulation of the fluids used in hydrodissection can improve the insulation effect of hydrodissection .

Active Techniques - Pneumodissection



When hydrodissection does not offer sufficient thermal insulation, pneumodissection is utilized; current research focuses on adjuvant passive techniques such as temperature monitoring, conscious sedation with biofeedback, and neurophysiologic monitoring to minimize adjacent tissue damage.

Active Techniques - Other

Although more rudimentary, direct skin protection and physical displacement are still effective strategies to protect surrounding tissue

Conclusion

Current evidence supports blending active and passive thermal protection measures to maximize procedural safety of musculoskeletal tumor ablation and expand indications.

Future research directions

- Prospective trials to validate new hydrogel technologies
- Further exploration and optimization of hydrogel material
- Establishment of guidelines and protocols to standardize biofeedback

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