Basic principles: Cryoablation

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Disclosure

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I have the following potential conflicts of interest to report:

- [ ] Consulting
- [ ] Employment in industry
- [ ] Stockholder of a healthcare company
- [ ] Owner of a healthcare company
- [x] Other(s): Bayer Healthcare (advisory board), Imactis (advisory board), Varian (honorarium)

- [ ] I do not have any potential conflict of interest
Outline - Cryoablation

• basic principles
  - technique
  - implementation
  - advantages / disadvantages

• clinical applications
Cryoablation

- reduction of temperature of target tissue below lethal -20°C

- two-chambered probe, flushed with compressed gases
  - argon: freezing
  - helium: thawing

- Joule-Thomson-effect: rapid decompression at tip results in temperature change (up to -140°C)

Hong K, Georgiades CS. In: Percutaneous Tumor Ablation, 2011
Cryoablation - Mechanism

Freeze-Thaw cycle:

intracellular ice crystal formation: bursting cell membrane / organelles

inflow of water into cells: cell volume ↑, cell membrane disruption
(repetition: more water for ice crystal formation available)

- direct cell injury
- vascular injury (thrombosis, ischemia)
- apoptosis (mitochondrial damage)
- immuno-stimulating effects / abscopal effect
(heat shock proteins…)

Hoffmann NE et al. Urology 2002;60(Suppl1):40-49
Cryoablation - Mechanism

“Shaping of the ice ball”
- number / type of applicators
- flow rate of gas \( \leftrightarrow \) diameter
- size of active tip \( \leftrightarrow \) length

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Cryoablation - Advantages

- good visualization of ice ball at imaging / controllability
- intrinsic analgesic effect (pain ↓)
- preservation of primary tissue structure (collagen, fibroblasts) → matrix for healing of tissue

peripheral nerves:
- axonotmesis
- Wallerian degeneration → potential for regeneration!

Drawbacks:
- requires more time
- cold sink effect
- higher risk of hemorrhage
- higher costs

Cryoablation - Applications

- primary tumors, metastases: kidney, musculoskeletal system, liver, lung, breast, prostate

- painful lesions / pain palliation: osteoid osteoma, (bone) metastases

65yo male, RCC
71yo female, soft tissue met.
59yo male, HCC recurr.
51yo male, pulm. met.

60yo female, urothelial carcinoma
12yo male, OO

Schmit GD et al. J Endourol 2010;24;1255-62
Yan YY et al. JVIR 2021;32(9):1277-87
Zhang H et al. Front Oncol 2023;13:1072054

Wu B et al. Skeletal Radiol 2011;40:1303-1310
Wallace AN et al. JVIR 2016;27:1788-1796
Khanmohammadi S et al. CVIR 2023; epub Jan 11
74yo female recurrent soft tissue sarcoma

51yo male, subpleural met (liposarcoma)

33yo male, s.p. traumatic lower limb amputation
Cryoablation

• established thermal ablation technique
• primary / secondary tumors (kidney, MSK, lung…), pain palliation

• preservation of primary tissue structure
• good controllability (visualization of the “ice ball”)
• intrinsic analgesic effect

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Thank you for your attention