

# **Implementing Liquid Nitrogen for Biological Reconstruction in a U.S. Hospital: Practical Setup, Surgical Pearls, and Lessons Learned**

Ana Cecilia Belzarena-Genovese, Jan Lesensky

## **INTRODUCTION:**

Liquid nitrogen (LN) has been widely used in international centers for devitalizing tumor-bearing bone, allowing biological reconstruction through autograft reimplantation. Despite promising results, adoption in U.S. hospitals remains limited due to apparent safety risks and logistical barriers.

## **Purpose**

To describe a practical approach for implementing LN-bone recycling for reconstruction in orthopedic oncology, with technical and surgical insights based on early institutional experience.

## **METHODS:**

We detail the key steps involved in safely introducing LN for bone recycling, including coordination with surgical services and hospital safety, procurement and storage protocols, and intraoperative workflow. Our freezing protocol consists of 20-minute submersion and 15-minute thaw cycles. Surgical pearls include protecting the skin with warm moist gauze and retractors to avoid thermal injury, preserving articular cartilage in epiphyseal tumors by avoiding direct exposure, and using pedicle-based recycling when feasible to preserve biological continuity. In patients with high BMI, submersion of large specimens can be challenging; preoperative planning and the use of larger or custom containers may be necessary. We also address common misconceptions regarding safety and operative time.

## **RESULTS:**

LN use was successfully integrated into our surgical oncology workflow without significant disruption or safety concerns. Coordination with hospital safety teams and surgical services allowed for seamless procurement, storage, and intraoperative use of LN. Intraoperative bone handling and fixation were comparable to standard techniques and did not result in additional increased operative time. Staff reported increased confidence with each subsequent case, and the setup was reproducible across different operating teams after proper training and protocol standardization.

## **DISCUSSION AND CONCLUSION:**

With proper planning, LN-based autograft recycling is a feasible option for biological reconstruction in the U.S. setting. It expands the armamentarium of limb salvage techniques and offers a durable, cost-effective alternative to allograft or endoprosthesis, especially relevant in young pediatric patients.