



## Case report

# Hip reconstruction with a combination of prosthesis and recycled autograft treated with liquid nitrogen in metastatic subtrochanteric fracture can improve quality of life: A case report

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## ABSTRACT

**Introduction and importance:** Palliative surgery with rigorously selected patients in treating metastatic bone tumour has become more popular recently. This article presents the use of autograft treated by liquid nitrogen in combination with hip prosthesis to reconstruct pathologically subtrochanteric fracture.

**Case presentation:** A 54-year-old male suffered left subtrochanteric fracture due to metastatic lesion from his lung cancer. He underwent one-stage surgery for hip tumour resection and reconstruction using the composite of tumour-bearing LNTA and hip prosthesis. He was able to sit in upright position on POD 1 and then to walk without support one month after the operation. His EORTC QLQ-C30 and EORTC QLQ-BM22 scores have significantly improved from 71 and 63 on POD 3 to 53 and 36 at one month after surgery, respectively.

**Clinical discussion:** Limb salvage surgery for pathological proximal hip fracture due to metastasis is always challenging. The goal of treatment must include pain-free affected limb with enough function to improve the QoL during the patient's end stage. Several reports on using frozen recycled autograft showed good results regarding anatomical matching, bone healing, function, and cost-effectiveness. We combined prosthesis and LNTA to manage the patient with end stage lung cancer and pathological proximal hip fracture. The patient was satisfied with the 6-month postoperative results before being deceased due to the widespread metastases.

**Conclusion:** Composite of LNTA and prosthesis might be a good alternative for treating metastatic fracture due to its anatomical matching, preservation of bone stock and cost-effectiveness where allograft and megaprosthesis are not available.

## 1. Introduction and importance

Bone and joint defect reconstruction for limb salvage has been a challenge for orthopaedic surgeons after removal of malignant epiphyseal tumour. The options of reconstruction could include internal fixation accompanied with cement spacer, composite of bone graft/prosthesis and general/personal megaprosthesis. It is necessary to have enough bone stock to support prosthesis when it is indicated. Recently, tumour-bearing frozen autograft has more commonly employed as a bony resource in bone and joint defect reconstructive procedures, especially in resource-constrained environments [1–3]. There were reports favouring the use of liquid nitrogen to extracorporeally treat

tumour-bearing bone instead of other methods such as irradiation, pasteurization and autoclaving due to its better osteoinductive ability [4,5] and preservation of compression strength of the treated bone [6]. Moreover, the liquid nitrogen-treated autograft (LNTA) was reported to have low recurrence rate of tumour in long term outcomes [3,7–9]. We report a case of hip reconstruction with long-stem prosthesis and LNTA for treating pathological subtrochanteric fracture.

This case report has been reported in line with the SCARE 2020 criteria [10].

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## 2. Case presentation

A 54-year-old male was admitted to our hospital due to left hip pain after slipping on the floor. A plain pelvic radiograph showed a comminuted subtrochanteric fracture of his left hip (Fig. 1). On his chest X-ray, there was a big solid area at the right upper lobe of lung (Fig. 2B). Biopsy with small needle showed non-small-cell lung carcinoma. Bone scintigraphy with Tc-99m detected metastatic lesions on the skull, left proximal humerus, bilateral ribs, thoracic vertebrae, right ilium and left subtrochanteric (Fig. 2A). The MRI showed the tumour lesion extended about 6 cm of the distal femoral fragment from the fracture site (Fig. 2D–E).

The operation was performed by the senior author (H.D.P) with the agreement of the patient and his family after several thorough discussions and consideration of his expectation. The hip extensive posterior approach was made. All the proximal third of femur was resected including proximal end, trochanteric block, 7 cm of proximal diaphyseal femur from the fracture site and soft tissue around the lesion grossly suspected containing tumour tissue. The femoral canal was also curetted to ensure the least remaining of tumour tissue.

After eliminating grossly suspected tumour tissue, the resected segments of tumour-bearing bone were treated (Fig. 3) following the procedure described by Tsuchiya et al. [11]. The excised portions were frozen in liquid nitrogen for 20 min, thawed at room temperature for 15 min and then thawed in distilled water for 10 min.

The recycled autograft was then refixed by a trochanteric hook plate, cerclage wires and cables (Fig. 3). A cemented long-stem bipolar hip prosthesis was implanted. Soft tissue was also re-attached layer by layer. The post-operative radiograph showed the stable construct (Fig. 4). The patient was able to sit in upright position on post-operative day (POD) 1.

Despite his comorbidity, he followed a rigorous rehabilitation program with great compliance. As a result, he was able to walk without support at 1 month after the operation (Fig. 5, Video 1). The EORTC QLQ-C30 and EORTC QLQ-BM22 scales were used on POD 3 and 1 month after surgery to evaluate the patient's quality of life (QoL). These scales were designed to address issues expected in patients with cancer [12]. All items are rated from a scale of 1 ("not at all") to 4 ("very much"), with the exception of the 2 items on the global health status scale in EORTC QLQ-C30, which are rated from 1 ("very poor") to 7 ("excellent")

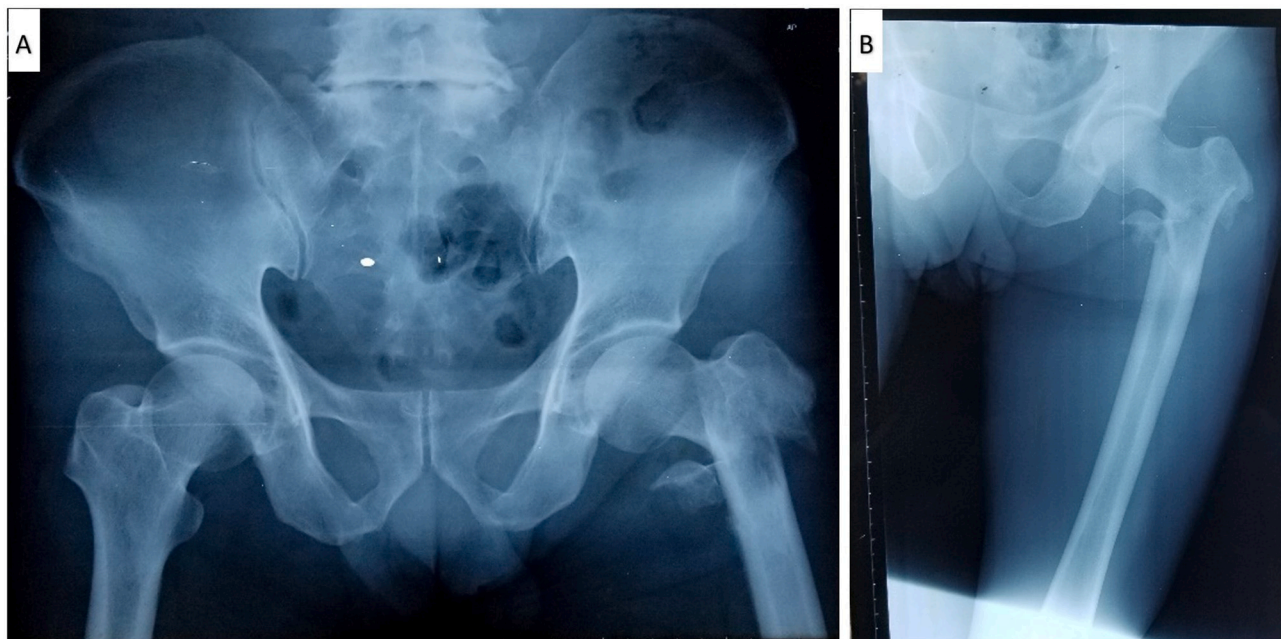
and scores of items 21 and 22 in EORTC QLQ-BM22 need to be reversed when interpreting since the higher scores of other items in the two scales indicate more severe problems. On POD 3, the patient rated 67, 4 (2 and 2) for symptom – functioning scales and global health status scale in EORTC QLQ-C30, respectively. He also rated 56, 7 (4 and 3) for the total scores of 20 items, scores of items 21 and 22 in EORTC QLQ-BM22, respectively. The scores were significantly improved one month after surgery with 41, 12 (6 and 6) and 28, 8 (4 and 4) in EORTC QLQ-C30 and EORTC QLQ-BM22 in the same order as previously mentioned, respectively. Unfortunately, the patient passed away due to the widespread of metastases after having 5 months of free ambulation.

## 3. Clinical discussion

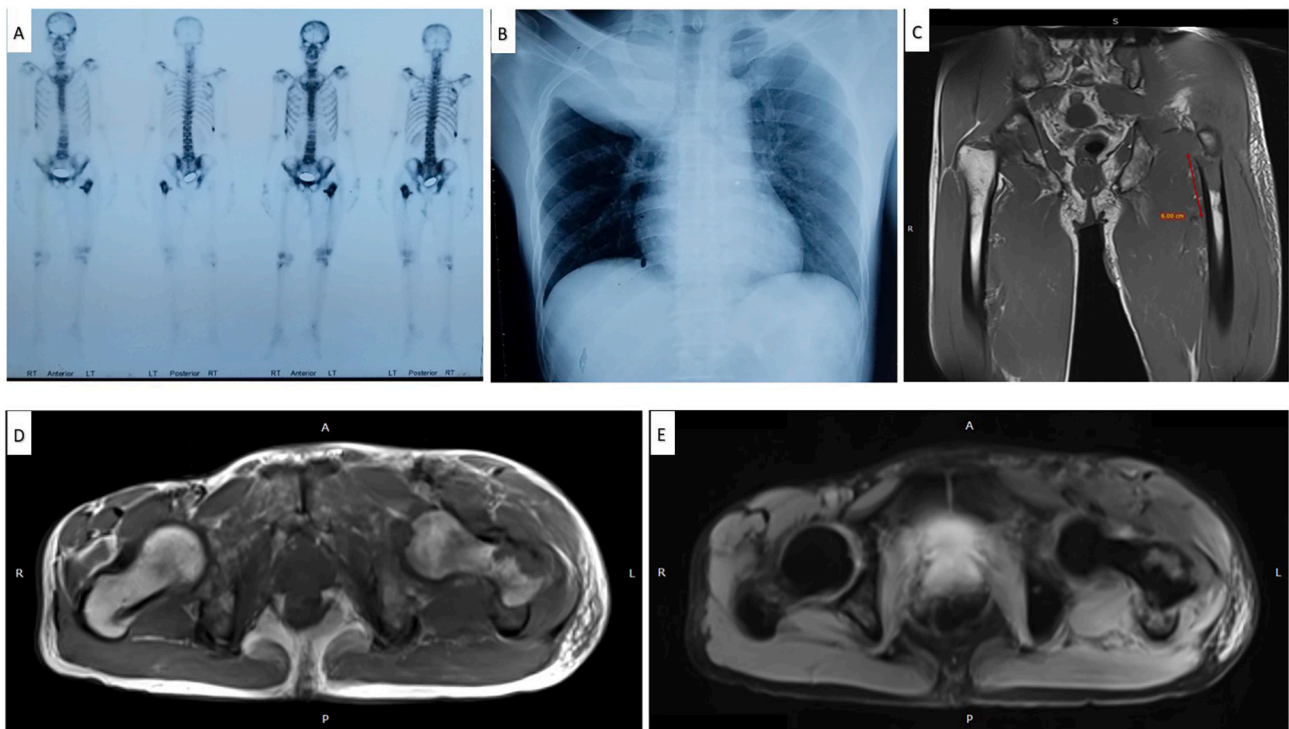
Limb salvage procedure using devitalised tumour-bearing autografts from excision of bone tumour has long been an alternative method of treatment besides implantation of megaprosthesis and amputation [13–16]. Recently, non-biological reconstruction of bone and joint defect after tumour resection has become much simple in the condition of the development of additive manufacturing [17,18]. It could enhance the progress of functional restoration and allow early weight bearing. The more the prosthesis is similar to the replaced structures, the more the reconstruction is stable. However, making prosthesis for individual is not always available. Biological reconstruction using bone graft could enhance stability of non-biologic reconstruction, especially when the graft could match anatomically with bone defect, and then with the prosthesis. The match is hardly achieved even though the bone bank could be possibly available.

In this case, the bone defect was located close to the hip joint made the utilisation of recycled autograft much more favourable. This method has the unique advantage of providing an anatomically size-matched graft while preserving bone stock of the patient. Regarding the accepted methods of bone recycling, frozen autograft using liquid nitrogen was reported to have better outcomes in terms of osteoinduction and preservation of compression strength than irradiation, autoclaving, and pasteurization [4–6].

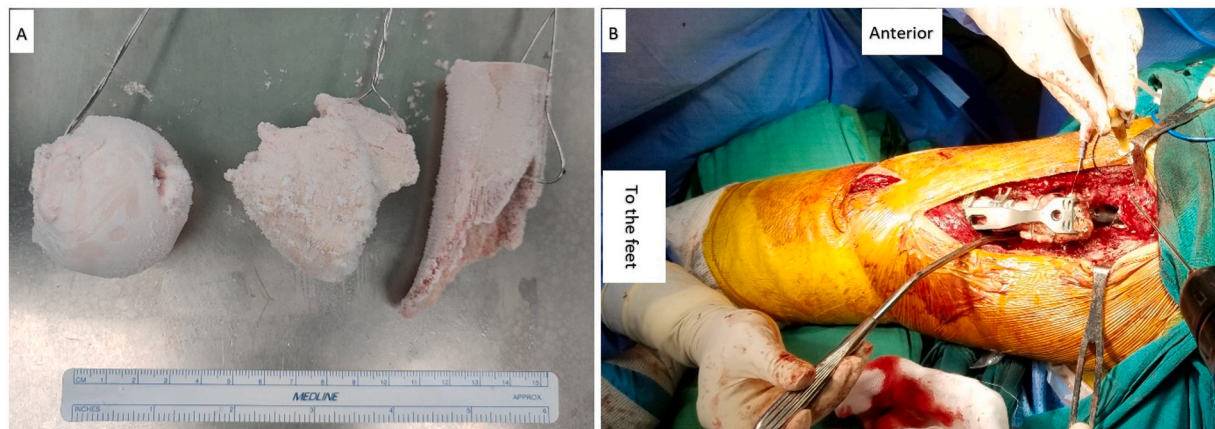
Recycling of resected bone using liquid nitrogen has become one of the methods of choice to reconstruct bone defect in orthopaedic oncology. In 1973, Marcove et al. reported their first series of twenty-



**Fig. 1.** The emergency radiographs demonstrate comminuted subtrochanteric fracture of the left femur with infiltrated osteolysis. 1A) Anterior – posterior pelvic view; 1B) Anterior – posterior view of the left femur.



**Fig. 2.** The extension of metastases lesions from non-small cell lung cancer. A) The bone scintigraphy illustrates metastatic lesions on the skull, left proximal humerus, bilateral ribs, thoracic vertebrae, right ilium and left subtrochanteric. B) The plain chest X-ray shows the main lesion at the right upper lung. C) The coronal slice from T1-weighted MRI shows the extended metastatic lesion to the distal fragment of the left femur. D) The axial slice from the T1-weighted MRI illustrates the metastatic lesion of proximal fragment of the left femur. E) The axial slice from the T2-weighted MRI illustrates the metastatic lesion of proximal fragment of the left femur.

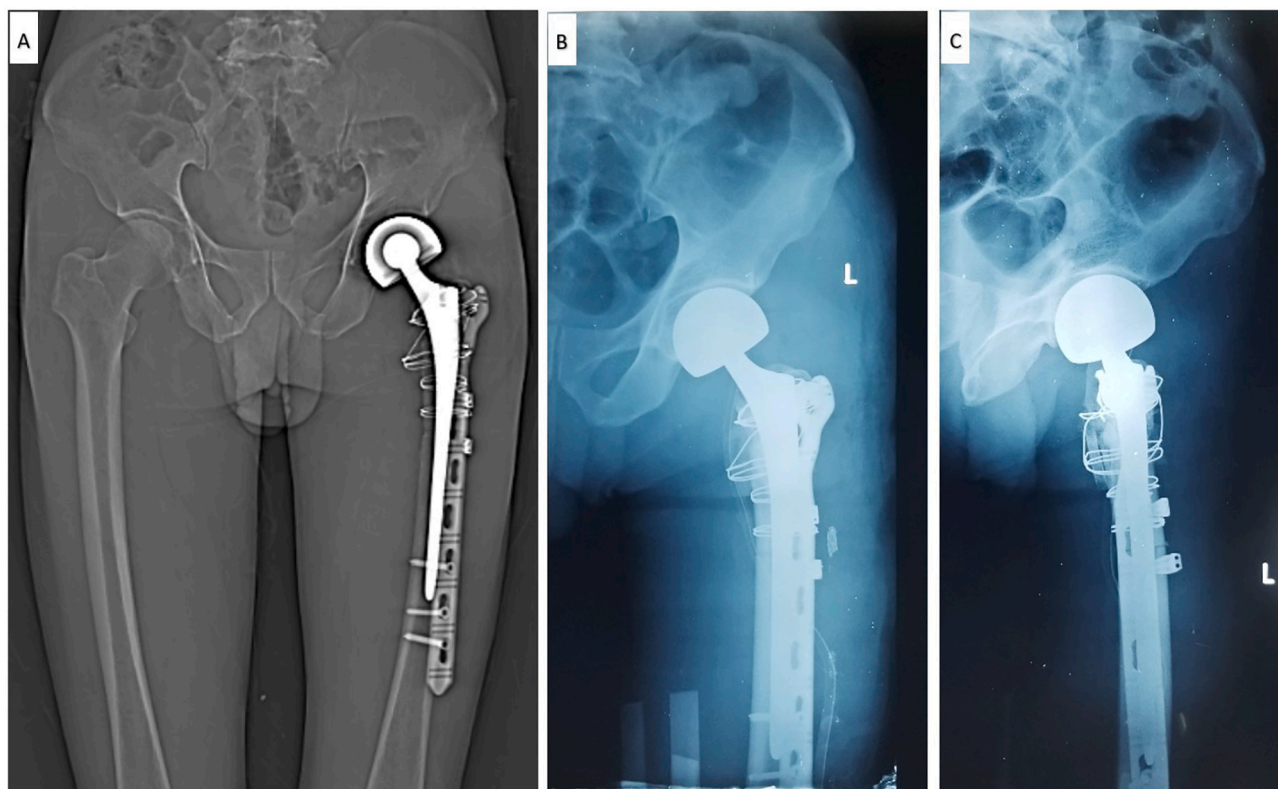


**Fig. 3.** Intraoperative images: (A) From left to right: the femoral head, trochanteric fragment, and the curretted distal fragment after being treated with liquid nitrogen in 20 min. (B) The final construct: the recycled autografts were fixed with cerclage wires and were augmented using trochanteric hook plate with cables before the cemented bipolar hip prosthesis was implanted.

five patients with giant-cell tumours treated by recycled autograft [19]. Twenty of the twenty-five patients were received the second-look biopsy to determine the efficacy of the initial curettage and cryosurgery. Thirteen patients with second-look procedures were negative in their biopsies and none of them had a recurrence after the mean follow-up time of 29 months. The authors found that twenty-three of the twenty-five tumours were eventually controlled by one or more applications of their treatment regimen. Most of recent studies demonstrated good clinical outcomes of frozen recycled autograft for the treatment of non-fractured musculoskeletal tumour with a relatively short time for bone union at the sites of osteotomy in the average of 5.2 months [7], 7.7 months [9], 10 months (in adults patients) [20]. If a cancer survivor still

lives long enough, by the recycled autograft healing, a non-biological reconstruction would be protected from mechanical loosening, mechanical wear and prosthetic/periprosthetic fracture.

In our case, the patient suffered from pathologic fracture at the proximal femur. The cancer lesion extended distally up to 6 cm of the distal fragment. Megaprosthesis would be an ideal treatment for this case. However, it could be impossible to find out an appropriate megaprosthesis during the time of social distancing due to the COVID-19 pandemic. Internal fixation (IM nailing, for example) with cement augmentation was also an alternative but the secondary bone tumour was still in place and could continue to progress leading to unexpected outcome by time if the patient lives long enough. We had also taken into



**Fig. 4.** Postoperative radiographs demonstrate the stable construct. (A) Pelvic anterior – posterior view, (B): Left femoral anterior – posterior view, (C): Left femoral lateral view.

account the patient's preference, life expectation and economic condition. The combination of non-biologic reconstruction (long stem hip prosthesis) with biologic reconstruction (liquid nitrogen recycled autograft) might be a wise decision at that moment when it included the advantages of both methods and feasibility.

The long stem hip prosthesis was used in combination with frozen autograft gave the anatomically size-match and the preservation of patient bone stock. However, due to the relatively long segment of recycled bone, trochanteric hook plate, cables, cerclage wires and bone cements were added to enforce stability of the final construct. This allowed the patients to immediately mobilise on POD 1 and help him rapidly regain his quality of life. It was demonstrated by his scores of EORTC QLQ-C30 on day 3 and 1 month after surgery. His symptom – functioning scales and his global health score were significantly improved from 56 to 41 (lower is better) and from 4 to 12 (higher is better), respectively. The patient's scores in the first 20 items of EORTC QLQ-BM22 showed his condition got remarkable improvements with the change from 56 to 28 (lower is better), especially in his painful sites, painful characteristics, functional interference, and psychosocial aspects. His scores of item 21 and item 22 in this scale had a slight enhancement with the change from 7 to 8 (higher is better) illustrated his optimistic attitude throughout the treatment therapy. Unfortunately, the patient died due to his respiratory failure after having 5 months of free ambulation with no adverse event relating to the hip reconstruction.

#### 4. Conclusion

Tumour-bearing autograft treated by liquid nitrogen has been a feasible alternative method and it is worth exploring in the case of resource-constrained environments, where allografts and mega-prostheses are not readily available. In palliative surgery for treating pathologic fracture, this method of reconstruction could give enough stability for patient to regain his/her quality of life even though bony

union has not been achieved yet.

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#### Ethical approval

This report was conducted in accordance with the World Medical Association Declaration of Helsinki.

#### Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

#### Research registration

Research Registry was not required.

#### Guarantor

Associate Professor Hung Do Phuoc MD, PhD.

#### Provenance and peer review

Not commissioned, externally peer-reviewed.



**Fig. 5.** The patient could mobilise without support at 1 month after the surgery. A) The patient could stand and mobilise without support. There was no limb's length discrepancy. B) The wound healing was uneventful.

#### CRediT authorship contribution statement

Hung Do Phuoc: conceptualising the plan for surgery, performing the surgery, writing the literature review for case report, reviewing the manuscript.

Phu Nguyen Hoang: Assisting the surgery, writing the draft for case report.

Duong Tran Binh: Preparing for the surgery, assisting the surgery.

Thanh Huynh Minh: Preparing for the surgery, assisting the surgery.

#### Declaration of competing interest

The authors declare no conflicts of interest in this work.

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