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Case Report

Well-Differentiated Thyroid Carcinoma Presenting with Sternal Invasion: Complex Resection and Reconstruction in the COVID-19 Era

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ABSTRACT

Background: Advanced thyroid malignancies may invade adjacent structures creating challenging approaches to surgical resection.

Methods: We report a 48-year-old gentleman who was found to have a papillary thyroid cancer with invasion of the sternum.

Results: The patient presented with pain and swelling in the upper chest. Computed tomography (CT) scanning demonstrated a paratracheal mass with invasion of the manubrium. Core needle biopsy demonstrated papillary thyroid cancer. Surgery was performed during the COVID-19 pandemic. En bloc total thyroidectomy with resection of the manubrium was performed. The defect was closed using a biological mesh, covered with a pectoralis major flap. Final pathology demonstrated a completely excised T4N1bM1 well-differentiated papillary thyroid carcinoma. The patient made an uneventful recovery.

Conclusion: En bloc total thyroidectomy with sternal resection can be performed safely with low morbidity. Reconstruction of the sternal defect can be performed with biological mesh and pedicled muscle flap to reduce infection risk.

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Introduction

Well-differentiated thyroid cancers (WDTC) are one of the most common endocrine tumors [1]. Locally advanced thyroid cancers can invade adjacent structures creating challenging approaches to surgical resection versus preservation of vital structures. Bone metastases can occur with follicular and locally advanced TCs, however direct invasion of the sternum has been rarely reported. We present the case of a patient with WDTC that presented with invasion of the sternum.

Case Report

A 48-year-old gentleman presented following an out of hospital cardiac arrest requiring on-site CPR by his wife and subsequently the ambulance

crew. Once resuscitated, he underwent primary percutaneous coronary intervention from which he made good recovery. Following this episode, however he complained of persistent pain and swelling in the left upper chest, which was initially attributed to rib fractures following CPR. Aside from ischaemic heart disease and hypertension, he did not have any other significant past medical history.

Computed tomography (CT) demonstrated a bulky paratracheal mass with osseous invasion of the manubrium with multiple peripheral lung nodules, shown in (Figure 1). Ultrasound -guided fine needle aspiration cytology and core needle biopsy confirmed papillary thyroid carcinoma (PTCa). The patient was referred for consideration of surgical treatment at our unit. The patient's case was fully reviewed and discussed at the multidisciplinary thyroid oncology tumour board (MDTOTB) and the

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decision was made to offer the patient surgical excision in form of total thyroidectomy level VI and VII neck dissection, partial sternectomy, surgical mesh and pectoralis major free flap reconstruction followed by radioiodine ablation and TSH management. Given the complexity of the lesion and the involvement of the sternum, surgery was performed as a combined procedure with Thoracic Surgery, Head and Neck and Plastic Surgery.

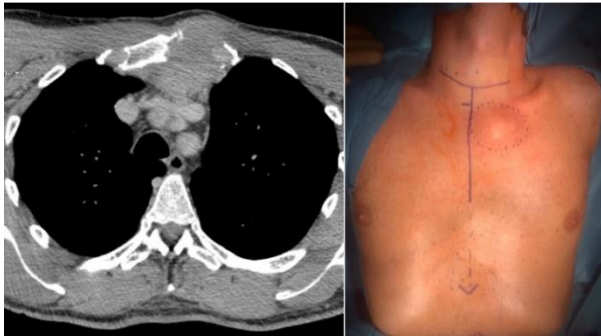


Figure 1: A) CT thorax demonstrating invasion of the manubrium by the tumor. B) Marking of initial incision with lesion seen left of the midline.

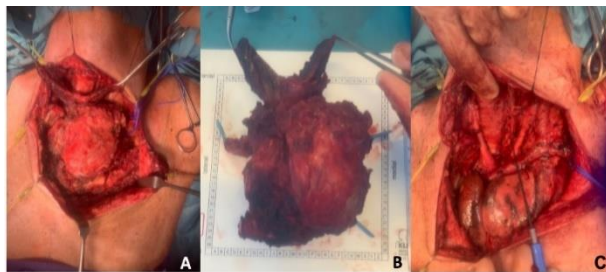


Figure 2: Photograph B demonstrates en bloc resection of thyroid with manubrium and resection of the head of the left clavicle and the origin of the first and second ribs bilaterally. C) Preservation of the recurrent laryngeal nerve, innominate and left subclavian veins.



Figure 3: Closure of defect with biological mesh (SurgiMend® 4mm thickness, Integra Lifesciences, New Jersey, USA).

The patient underwent curative surgery during the COVID-19 pandemic as treatment could not be postponed due to the advanced disease. Protocolised COVID-19 measures were undertaken with appropriate consent. Intraoperative recurrent laryngeal nerve monitoring was used (NIM III Medtronic®). Via a T-shaped incision, as shown in (Figure 2), the patient underwent total thyroidectomy with en-bloc resection of the

manubrium sterni together with the head of the left clavicle and the origin of the first and second ribs bilaterally, shown in (Figure 3). The resection was completed with preservation of both recurrent laryngeal nerves, the two superior parathyroid glands, trachea, oesophagus, and both innominate vein and left subclavian vein shown in (Figure 4).



Figure 4: Pectoral flap coverage of the A) mesh and B) closure.

To reconstruct the defect, a biological mesh (SurgiMend® 4mm thickness, Integra Lifesciences, New Jersey, USA) was selected, as demonstrated in (Figure 3), to provide stability by bridging the bony gap. This was tailored from a template of the defect and secured to the sternum, the right clavicular head and the left clavicle using a number 5 polyester sutures to provide stability to the clavicles. An ipsilateral left pectoralis major, muscle-only, flap was raised, islanded on its pedicle and transposed to the defect, between the mesh and the skin. Flap elevation was performed through the initial 'T' incision and no further access incisions were made in order to avoid vascular compromise to the skin, as seen in (Figure 4).

The patient made an uneventful clinical recovery, with no neurological deficit and preserved full range of motion of both shoulders. Bone profile and parathyroid hormone were normal, and he was discharged 10 days after the surgery. The histopathological analysis demonstrated pT4N1b well-differentiated papillary thyroid carcinoma with an R1 resection. There was a bony lesion in the first rib which demonstrated local metastatic spread.

The histopathology and adjuvant treatment were discussed at the MDTOTB and it was agreed for him to proceed to radioiodine ablation at dose of 5.5 GBq (148.6 millicurie) with thyroid-stimulating hormone suppression.

Discussion

This case illustrates the challenges involved in resection of WDTC with localised bony invasion. The majority of patients with WDTC present with early, localised disease and these patients have an excellent prognosis but approximately 5-15% will present with locally advanced disease [2]. The majority of reported cases with WDTC that present with bone metastatic lesions show separate deposits distant from the primary tumor and are follicular carcinomas, which are known to disseminate via a haematogenous spread [3]. The incidence of separate sternal metastasis in thyroid cancer is approximately 25%, which has implications for staging, treatment and prognosis [4]. Given the poor prognosis with bone metastases and the limited effect of radioiodine therapy on bone lesions

in thyroid cancer, radical surgery should be considered where there is bone involvement, providing a complete macroscopic resection can be achieved with low morbidity [5]. This may also help to improve prognosis and the efficacy of radioiodine treatment [6]. This is likely to necessitate surgery being performed in a team with a combination of surgical specialties, such as in our patient.

WDTC, especially papillary thyroid cancers (PTC), can potentially invade adjacent structures, mainly the recurrent laryngeal nerves (RLN), strap muscles or trachea. This often occurs when tumors de-differentiate. The occurrence of a well-differentiated PTC with direct anterior invasion to the sternum has to our knowledge not been reported previously. The potential mechanism of this is difficult to explain, however as the patient had vigorous CPR prior to the appearance of the mass, one could potentially hypothesise that the tumor capsule could have been breached and the bone cortex broken. This, in turn would have induced an invasive process in the sternum-tumor capsule interface. Our patient was discussed in the local MDTOTB and the decision was made to proceed with surgical resection, however, given the direct invasion of the sternum meant a complex resection and reconstruction and involvement of a number of surgical teams. Timing of surgery is a critical decision. This patient presented during the COVID-19 pandemic, which added an extra layer of risk and complexity - the risks of perioperative COVID-19 infection vs benefit of timely treatment were carefully discussed amongst the MDT team and the patient and his family. Preliminary data from COVIDSurg has demonstrated a mortality risk of 20-25% in patients undergoing surgery who test positive for the coronavirus causing COVID-19 [7].

Reconstruction of composite (bone and soft tissue) thoracic defects is demanding due to the functional nature of the thoracic cage and the need to protect underlying critical structures. Bone and soft tissue reconstruction should be considered separately. Multiple methods of reconstruction of the sternum have been described including methyl methacrylate and synthetic mesh [8-10]. Our preference ordinarily would be to reconstruct the neo-manubrium with a vascularised bone flap (e.g., free fibula) to provide stability and vascularity. However, the priority in the COVID-19 era for minimising surgical time and complexity demanded a simpler solution. The choice of material for reconstruction should take into account patient, and arguably, environmental factors. In our patient, the choice of material for reconstruction was made in view of the COVID-19 pandemic that was present at the time of offering surgery. In order to provide a secure and stable method of reconstruction of the sternum with low risk of infection, a biological mesh (SurgiMend® 4mm thickness, Integra Lifesciences, New Jersey, USA) was chosen. This versatile biological mesh is composed of bovine derived acellular collagen matrix. It provides adequate tensile strength, particularly when using a mesh of 4mm thickness. The biological mesh allows for native cell re-population and vascularisation of the mesh. Typically, this occurs within approximately 10-12 weeks [11]. Whilst a methyl methacrylate sternal reconstruction could have been performed in this case, the decision was made to use a biological mesh to reduce the risk of infection given that the superficially, the sternum is not as well-vascularised. In order to prevent wound breakdown, and potential early infection of the mesh, we elected to perform a muscle flap reconstruction. This also has the advantage of giving further stability to the anterior chest wall and also reducing deformity and paradoxical chest movement.

The purpose of the mesh reconstruction is two-fold. Firstly, it fills the defect following resection of the sternum. Secondly, it provides stability mainly when resection of the clavicle is involved. In our patient, the head of the left clavicle was resected. To ensure stability of the shoulder joint, the mesh is required to be fixed to both clavicles. The 4mm thickness of the mesh used in our patient's case provides more stability than using a thinner mesh or any other type of synthetic mesh, such as Gore-Tex® (Gore Medical, Delaware, USA). In terms of soft tissue reconstruction, the priorities were to fill the dead space and provide a well-vascularised cover to increase mesh viability. The pectoralis major was an ideal flap for this purpose due to its ability to conform to defect shape, superior size and vascularity. Meticulous preservation of the flap vessels (pectoral branch of the thoracoacromial artery) was a critical manoeuvre in the tumor dissection to make this feasible. Fortunately, no skin resurfacing was required, and the wound was closed directly. Locally invasive thyroid cancers are often treated with radioiodine ablation and postoperative external beam radiotherapy therapy (EBRT) [1]. In view of the fact that this was a T4bN1bM1 well-differentiated PTC the decision was made to treat the patient with RAI at a higher dose of 5.5 Gbq (148.6 millicuries) and reserve EBRT if needed.

Conclusion

We have described an extraordinary case of well-differentiated PTC with direct invasion to the sternum. Radical surgical resection with resection of the sternum can be performed safely with low morbidity with appropriate planning and a multidisciplinary team approach. Surgical management in such cases requires the ability to achieve complete macroscopic resection, with appropriate and viable options for reconstruction. Consideration should be given to methods of reducing the risk of local infection, especially during the COVID-19 pandemic. Given the improvement in survival when bony lesions are resected in the context of thyroid cancer, surgical resection for advanced, locally invasive tumors should be considered.

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Author Contributions

Each author contributed equally to the drafting and review of the manuscript.

Consent

The patient has given written, informed consent to publish their case, including publication of images.

Conflicts of Interest

None.

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