

World Journal of *Clinical Cases*

World J Clin Cases 2021 April 6; 9(10): 2160-2418



MINIREVIEWS

- 2160 Tertiary peritonitis: A disease that should not be ignored
Marques HS, Araújo GRL, da Silva FAF, de Brito BB, Versiani PVD, Caires JS, Milet TC, de Melo FF
- 2170 SARS-CoV-2, surgeons and surgical masks
Khalil MI, Banik GR, Mansoor S, Alqahtani AS, Rashid H

ORIGINAL ARTICLE**Case Control Study**

- 2181 Igaratimod promotes transformation of mononuclear macrophages in elderly patients with rheumatoid arthritis by nuclear factor- κ B pathway
Liu S, Song LP, Li RB, Feng LH, Zhu H

Retrospective Study

- 2192 Factors associated with overall survival in early gastric cancer patients who underwent additional surgery after endoscopic submucosal dissection
Zheng Z, Bu FD, Chen H, Yin J, Xu R, Cai J, Zhang J, Yao HW, Zhang ZT
- 2205 Epidemiological and clinical characteristics of 65 hospitalized patients with COVID-19 in Liaoning, China
Zhang W, Ban Y, Wu YH, Liu JY, Li XH, Wu H, Li H, Chen R, Yu XX, Zheng R
- 2218 Comprehensive clinicopathologic characteristics of intraabdominal neurogenic tumors: Single institution experience
Simsek C, Uner M, Ozkara F, Akman O, Akyol A, Kav T, Sokmensuer C, Gedikoglu G
- 2228 Distribution and drug resistance of pathogens in burn patients in China from 2006 to 2019
Chen H, Yang L, Cheng L, Hu XH, Shen YM

Observational Study

- 2238 Impact of simethicone on bowel cleansing during colonoscopy in Chinese patients
Zhang H, Liu J, Ma SL, Huang ML, Fan Y, Song M, Yang J, Zhang XX, Song QL, Gong J, Huang PX, Zhang H

Prospective Study

- 2247 Effect of suspension training on neuromuscular function, postural control, and knee kinematics in anterior cruciate ligament reconstruction patients
Huang DD, Chen LH, Yu Z, Chen QJ, Lai JN, Li HH, Liu G

CASE REPORT

- 2259 Turner syndrome with positive SRY gene and non-classical congenital adrenal hyperplasia: A case report
He MN, Zhao SC, Li JM, Tong LL, Fan XZ, Xue YM, Lin XH, Cao Y

- 2268** Mechanical thrombectomy for acute occlusion of the posterior inferior cerebellar artery: A case report
Zhang HB, Wang P, Wang Y, Wang JH, Li Z, Li R
- 2274** Bilateral retrocorneal hyaline scrolls secondary to asymptomatic congenital syphilis: A case report
Jin YQ, Hu YP, Dai Q, Wu SQ
- 2281** Recurrent undifferentiated embryonal sarcoma of the liver in adult patient treated by pembrolizumab: A case report
Yu XH, Huang J, Ge NJ, Yang YF, Zhao JY
- 2289** Adult onset type 2 familial hemophagocytic lymphohistiocytosis with *PRF1* c.65delC/c.163C>T compound heterozygous mutations: A case report
Liu XY, Nie YB, Chen XJ, Gao XH, Zhai LJ, Min FL
- 2296** Salvage of vascular graft infections *via* vacuum sealing drainage and rectus femoris muscle flap transposition: A case report
Zhang P, Tao FL, Li QH, Zhou DS, Liu FX
- 2302** Innovative chest wall reconstruction with a locking plate and cement spacer after radical resection of chondrosarcoma in the sternum: A case report
Lin CW, Ho TY, Yeh CW, Chen HT, Chiang IP, Fong YC
- 2312** Changes in sleep parameters following biomimetic oral appliance therapy: A case report
Singh GD, Kherani S
- 2320** Bone remodeling in sigmoid sinus diverticulum after stenting for transverse sinus stenosis in pulsatile tinnitus: A case report
Qiu XY, Zhao PF, Ding HY, Li XS, Lv H, Yang ZH, Gong SS, Jin L, Wang ZC
- 2326** Prolonged use of bedaquiline in two patients with pulmonary extensively drug-resistant tuberculosis: Two case reports
Gao JT, Xie L, Ma LP, Shu W, Zhang LJ, Ning YJ, Xie SH, Liu YH, Gao MQ
- 2334** Low-grade mucinous appendiceal neoplasm mimicking an ovarian lesion: A case report and review of literature
Borges AL, Reis-de-Carvalho C, Chorão M, Pereira H, Djokovic D
- 2344** Granulomatosis with polyangiitis presenting as high fever with diffuse alveolar hemorrhage and otitis media: A case report
Li XJ, Yang L, Yan XF, Zhan CT, Liu JH
- 2352** Primary intramedullary melanoma of lumbar spinal cord: A case report
Sun LD, Chu X, Xu L, Fan XZ, Qian Y, Zuo DM
- 2357** Proliferative glomerulonephritis with monoclonal immunoglobulin G deposits in a young woman: A case report
Xu ZG, Li WL, Wang X, Zhang SY, Zhang YW, Wei X, Li CD, Zeng P, Luan SD

- 2367** *Nocardia cyriacigeorgica* infection in a patient with pulmonary sequestration: A case report
Lin J, Wu XM, Peng MF
- 2373** Long-term control of melanoma brain metastases with co-occurring intracranial infection and involuntary drug reduction during COVID-19 pandemic: A case report
Wang Y, Lian B, Cui CL
- 2380** Solitary bone plasmacytoma of the upper cervical spine: A case report
Li RJ, Li XF, Jiang WM
- 2386** Two-stage transcrestal sinus floor elevation-insight into replantation: Six case reports
Lin ZZ, Xu DQ, Ye ZY, Wang GG, Ding X
- 2394** Programmed cell death protein-1 inhibitor combined with chimeric antigen receptor T cells in the treatment of relapsed refractory non-Hodgkin lymphoma: A case report
Niu ZY, Sun L, Wen SP, Song ZR, Xing L, Wang Y, Li JQ, Zhang XJ, Wang FX
- 2400** Pancreatic cancer secondary to intraductal papillary mucinous neoplasm with collision between gastric cancer and B-cell lymphoma: A case report
Ma YH, Yamaguchi T, Yasumura T, Kuno T, Kobayashi S, Yoshida T, Ishida T, Ishida Y, Takaoka S, Fan JL, Enomoto N
- 2409** Acquired haemophilia in patients with malignant disease: A case report
Krašek V, Kotnik A, Zavrtnik H, Klen J, Zver S

ABOUT COVER

Editorial Board Member of *World Journal of Clinical Cases*, Deb Sanjay Nag, Senior Consultant, Department of Anaesthesiology, Tata Main Hospital, C-Road (West), Bistupur, Jamshedpur 831 001, India. ds.nag@tatasteel.com

AIMS AND SCOPE

The primary aim of *World Journal of Clinical Cases* (*WJCC*, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

INDEXING/ABSTRACTING

The *WJCC* is now indexed in Science Citation Index Expanded (also known as SciSearch®), Journal Citation Reports/Science Edition, Scopus, PubMed, and PubMed Central. The 2020 Edition of Journal Citation Reports® cites the 2019 impact factor (IF) for *WJCC* as 1.013; IF without journal self cites: 0.991; Ranking: 120 among 165 journals in medicine, general and internal; and Quartile category: Q3. The *WJCC*'s CiteScore for 2019 is 0.3 and Scopus CiteScore rank 2019: General Medicine is 394/529.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: Yan-Xia Xing; Production Department Director: Yun-Xiaojuan Wu; Editorial Office Director: Jin-Li Wang.

NAME OF JOURNAL

World Journal of Clinical Cases

ISSN

ISSN 2307-8960 (online)

LAUNCH DATE

April 16, 2013

FREQUENCY

Thrice Monthly

EDITORS-IN-CHIEF

Dennis A Bloomfield, Sandro Vento, Bao-Gan Peng

EDITORIAL BOARD MEMBERS

<https://www.wjgnet.com/2307-8960/editorialboard.htm>

PUBLICATION DATE

April 6, 2021

COPYRIGHT

© 2021 Baishideng Publishing Group Inc

INSTRUCTIONS TO AUTHORS

<https://www.wjgnet.com/bpg/gerinfo/204>

GUIDELINES FOR ETHICS DOCUMENTS

<https://www.wjgnet.com/bpg/gerinfo/287>

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH

<https://www.wjgnet.com/bpg/gerinfo/240>

PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/gerinfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/gerinfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>

Innovative chest wall reconstruction with a locking plate and cement spacer after radical resection of chondrosarcoma in the sternum: A case report

Chung-Wei Lin, Tsung-Yu Ho, Chen-Wei Yeh, Hsien-Te Chen, I-Ping Chiang, Yi-Chin Fong

ORCID number: Chung-Wei Lin 0000-0002-6993-6814; Tsung-Yu Ho 0000-0002-8644-7211; Chen-Wei Yeh 0000-0001-7071-4322; Hsien-Te Chen 0000-0002-5035-4005; I-Ping Chiang 0000-0002-0549-3823; Yi-Chin Fong 0000-0002-0284-7286.

Author contributions: Chen HT designed the concept; Fong YC was the attending doctor and treated the patient; Lin CW and Ho TY contributed to literature review and manuscript drafting; Lin CW and Yeh CW revised the manuscript; Chiang IP performed histopathological analysis.

Informed consent statement: The patient provided consent for the treatment and the use of his medical documentation and information for the present article.

Conflict-of-interest statement: The authors declare that they have no conflict of interest to disclose.

CARE Checklist (2016) statement: The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

Open-Access: This article is an open-access article that was selected by an in-house editor and

Chung-Wei Lin, Tsung-Yu Ho, Hsien-Te Chen, Yi-Chin Fong, Department of Orthopedic Surgery, China Medical University Hospital, China Medical University, Taichung City 40454, Taiwan

Chen-Wei Yeh, Department of Education, China Medical University Hospital, China Medical University, Taichung City 40447, Taiwan

Hsien-Te Chen, Yi-Chin Fong, Department of Sports Medicine, College of Health Care, China Medical University, Taichung City 40402, Taiwan

Hsien-Te Chen, Spine Center, China Medical University Hospital, China Medical University, Taichung City 40454, Taiwan

I-Ping Chiang, Department of Pathology, China Medical University Hospital, China Medical University, Taichung 40454, Taiwan

Yi-Chin Fong, Department of Orthopedic Surgery, China Medical University Beigang Hospital, Yunlin County 65152, Taiwan

Corresponding author: Yi-Chin Fong, MD, Chief Doctor, Professor, Department of Orthopedic Surgery, China Medical University Hospital, China Medical University, No. 2 Xueshi Road, North District, Taichung City 40454, Taiwan. d1762@mail.cmuh.org.tw

Abstract

BACKGROUND

Chondrosarcoma, a cartilage matrix producing tumor, is the second most commonly observed primary bone tumor after osteosarcoma, accounting for 15% of all chest wall malignancies. We herein report the case of a patient with chondrosarcoma of the sternum and our management of the chest wall defects that presented following radical tumor resection.

CASE SUMMARY

A 31-year-old patient presented to our hospital with dull pain and a protruding mass overlying the chest for 3 mo. The presence of nocturnal pain and mass size progression was reported, as were overhead arm elevation-related limitations. Computed tomography showed a focal osteoblastic mass in the sternum with bony exostosis and adjacent soft tissue calcification. Positron emission tomography-computed tomography revealed hypermetabolic activity with a mass

fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

Manuscript source: Unsolicited manuscript

Specialty type: Medicine, research and experimental

Country/Territory of origin: Taiwan

Peer-review report's scientific quality classification

Grade A (Excellent): A
Grade B (Very good): D
Grade C (Good): C
Grade D (Fair): D
Grade E (Poor): 0

Received: October 1, 2020

Peer-review started: October 1, 2020

First decision: December 28, 2020

Revised: January 10, 2021

Accepted: January 25, 2021

Article in press: January 25, 2021

Published online: April 6, 2021

P-Reviewer: Grignani G, Shimada S, Zhu Y

S-Editor: Gao CC

L-Editor: Wang TQ

P-Editor: Yuan YY



located over the upper sternum. Magnetic resonance imaging showed a focal ill-defined bony mass of the sternum with cortical destruction and periosteal reaction. Preoperative biopsy showed a consistent result with chondrosarcoma with immunohistochemical positivity for S100 and focal positivity for IDH-1. The grade II chondrosarcoma diagnosis was confirmed by postoperative pathology. The patient underwent radical tumor resection and chest wall reconstruction with a locking plate and cement spacer. The patient was discharged 1 wk after surgery without any complications. At the 1-year follow-up, there was no local recurrence on imaging. The functional scores, including Constant Score, Nottingham Clavicle Score, and Oxford Shoulder Score, showed the absence of pain in the performance of daily activities or substantial functional disabilities.

CONCLUSION

The diagnosis of chondrosarcoma must be considered when chest wall tumors are encountered. The surgical reconstructive materials, with a locking plate and cement spacer, used in our study are cost-effective and readily-available for the sternum defect.

Key Words: Chondrosarcoma; Sternum; Chest wall; Cement; Reconstruction; Case report

©The Author(s) 2021. Published by Baishideng Publishing Group Inc. All rights reserved.

Core Tip: Chondrosarcoma is the second most commonly observed primary bone tumor after osteosarcoma, accounting for 15% of all chest wall malignancies. Radical tumor excision is deemed the gold standard treatment. However, reconstruction of chest wall defect following tumor resection remains challenging. Our clinical case presents an innovative surgical procedure in managing chest wall defect. The surgical reconstructive materials including a locking plate and cement spacer are cost-effective and readily-available. We believe this technique, which yielded promising results, may serve as an alternative in cases such as ours.

Citation: Lin CW, Ho TY, Yeh CW, Chen HT, Chiang IP, Fong YC. Innovative chest wall reconstruction with a locking plate and cement spacer after radical resection of chondrosarcoma in the sternum: A case report. *World J Clin Cases* 2021; 9(10): 2302-2311

URL: <https://www.wjgnet.com/2307-8960/full/v9/i10/2302.htm>

DOI: <https://dx.doi.org/10.12998/wjcc.v9.i10.2302>

INTRODUCTION

Chondrosarcomas are the second most commonly observed primary bone tumors after osteosarcoma, and the majority of these are observed in middle-aged populations^[1,2]. The characteristics of chondrosarcoma include slow tumor growth, low-grade disease, extremely low rates of metastasis, and slight male predominance. Primary bone tumors located over the chest wall are rarely observed, and account for less than 1% of all primary bone neoplasms^[3,4]. However, 15% of chondrosarcomas are located over the chest wall, with an annual incidence of 0.5 million/year^[5,6]. Since chondrosarcomas are resistant to radiotherapy and chemotherapy, wide tumor excision followed by anterior chest wall reconstruction is deemed the gold standard for treatment^[7].

Generally, chest wall defects larger than 5 cm require surgical reconstruction for functional and cosmetic purposes^[8-10]. Reconstructive procedures are performed with the aim of restoring the stability and rigidity of the thoracic cage, eliminating thoracic dead space, preserving pulmonary function, protecting the major intra-thoracic organs, providing adequate soft tissue coverage, and optimizing the patient's cosmetic appearance. The reconstruction is considered challenging regarding the proximity of major vital organs and difficulties in finding suitable materials. Previous studies with variable tumors located on the sternum reported various methods of sternal reconstruction, including those performed using a methyl methacrylate Marlex mesh sandwich plate, titanium mesh, titanium plate and stainless steel plate, allograft transplantation, and three-dimensional custom-made prosthesis^[4,11-15]. Ideally, the

materials used for these purposes must be readily-available, durable, and cost-effective. The lack of flexibility of metal prosthesis could lead to unexpected breakage or potential dislocation if malpositioned. Other issues include inaccurate sizing or restriction of movement after surgery^[4]. Allograft transplantation takes the major advantage in the ability to incorporate into native tissue and revascularization. However, bone allograft comes in limited source and bears the risk of disease transmission^[10]. Three-dimensional custom-made prosthesis achieves a perfect shape in chest wall reconstruction process but is deemed time-consuming and costly^[4].

The advantages of using cement spacer for chest wall reconstruction include low cost and being durable, readily-available, and most importantly moldable based on individual body size. Accordingly, we sought to present the case of a patient who underwent bilateral sternoclavicular joint fixation and cement spacer augmentation following radical tumor resection.

CASE PRESENTATION

Chief complaints

A 31-year-old man presented to our hospital with dull and nocturnal pain. A protruding mass overlying the left side chest wall with progressive growing was noted.

History of present illness

According to the patient's statement, the mass gradually increased in size over these 3 mo. The pain interfered with the patient's performance of daily activities. There were no symptoms related to airway compression or respiratory disturbance.

History of past illness

The patient had a past history of left lower lobe lung adenocarcinoma *in situ* and underwent wedge resection 3 mo ago.

Personal and family history

The patient had no family history.

Physical examination

Physical examination revealed tenderness on palpation and the presence of a firm, non-movable, well-defined 5 cm mass. The motion of the left shoulder and overhead arm elevation was interfered by this mass. There was no other palpable mass over the head, neck, or axillary lymph nodes.

Laboratory examinations

The results of the laboratory tests, including those for complete blood count, biochemical profiling, and coagulation function, were all within the normal range.

Imaging examinations

Computed tomography (CT) with contrast showed a focal osteoblastic mass in sternum manubrium region with bony exostosis and adjacent soft tissue calcification (Figure 1). Positron emission tomography-computed tomography (PET-CT) revealed the presence of hypermetabolic activity with a mass located over the upper sternum (Figure 2). Bone scintigraphy also revealed increased focal uptake in the area, indicating a strong suspicion of a primary sternal tumor (Figure 3). Magnetic resonance imaging (MRI) showed a focal ill-defined bony mass of the sternum with cortical destruction and periosteal reaction. The tumor size was approximately 5.0 cm × 4.2 cm × 5.2 cm, with an edge abutting the aortic arch (Figure 4). The presence of malignancies including chondrosarcoma was suspected in the differential diagnosis.

Preoperative biopsy

Section through the tumor at the sternum showed hypercellularity and contained groups of neoplastic chondrocytes with extensive chondroid matrix component. The tumor cells had enlarged, hyperchromatic nuclei and occasional binucleation. Some bony fragments were also present. The immunostaining of the tumor cell revealed positivity for S100 and focal positivity for IDH-1. It was consistent with grade II chondrosarcoma.

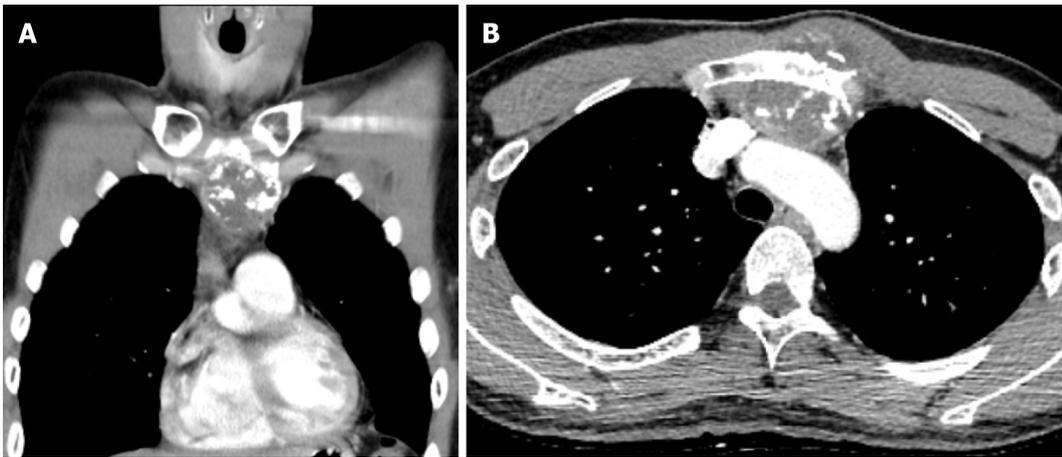


Figure 1 Focal osteoblastic mass in the sternum with bony exostosis and adjacent soft tissue calcification. A and B: Coronal (A) and axial (B) views of contrast computed tomography.

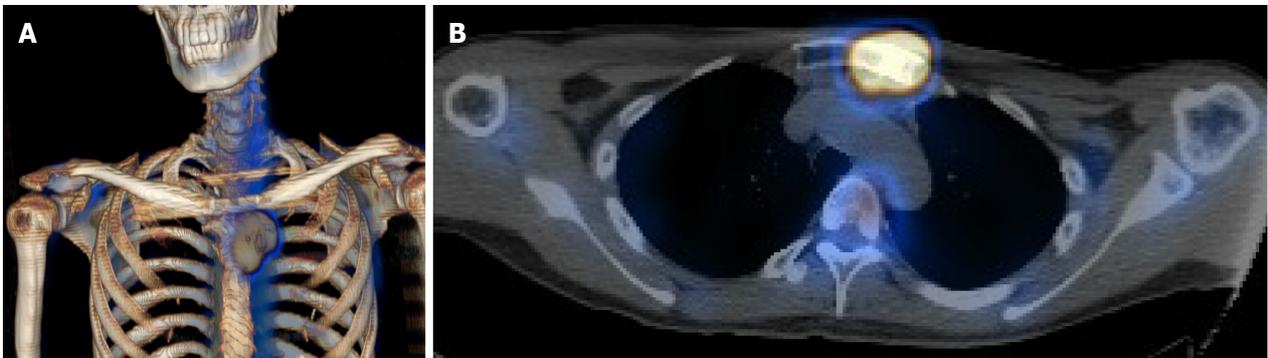


Figure 2 Hypermetabolic mass overlying the upper sternum. A and B: Three-dimensional reconstruction and axial view of positron emission tomography-computed tomography image.

Pathological findings

The gross specimen showed a 6.5 cm × 6.0 cm × 5.0 cm gelatinous and elastic to firm tumor mass composed of hyaline cartilage (Figure 5). Pathology suggested grade II moderately differentiated chondrosarcoma with clear and uninvolved margins. Hematoxylin and eosin (HE) staining indicated less cellularity without atypia and a lobulated architecture with abundant cartilaginous matrix separated by the fibrovascular bands. The spread trabecular bone filled the lacunar space, which was surrounded by the hyaline cartilaginous matrix (Figure 6).

MULTIDISCIPLINARY EXPERT CONSULTATION

Preoperative evaluation and preparation were performed over the first few days following admission. A multidisciplinary tumor board, comprising chest surgeons, orthopedic surgeons, anesthesiologists, and radiologists, was established. After a detailed discussion, the performance of radical resection and chest wall reconstruction, with a goal of complete tumor eradication, was decided on. The advantages and disadvantages associated with the procedure, surgical morbidities, and surgical-related risks were explained clearly to the patient and his family members.

FINAL DIAGNOSIS

The final diagnosis was grade II moderately differentiated chondrosarcoma.

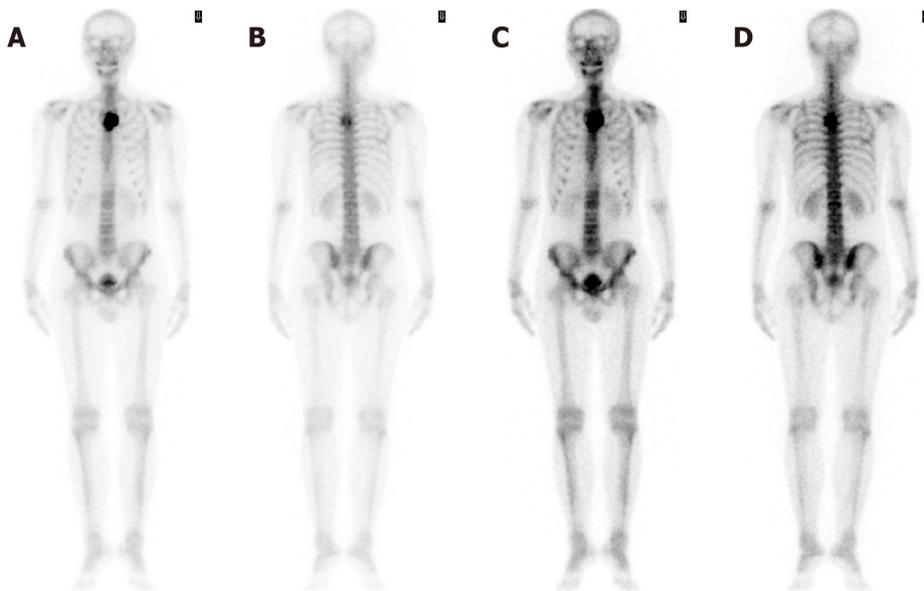


Figure 3 Bone scintigraphy revealing increased focal uptake in the sternum, showing a strong suspicion of a primary sternal tumor.

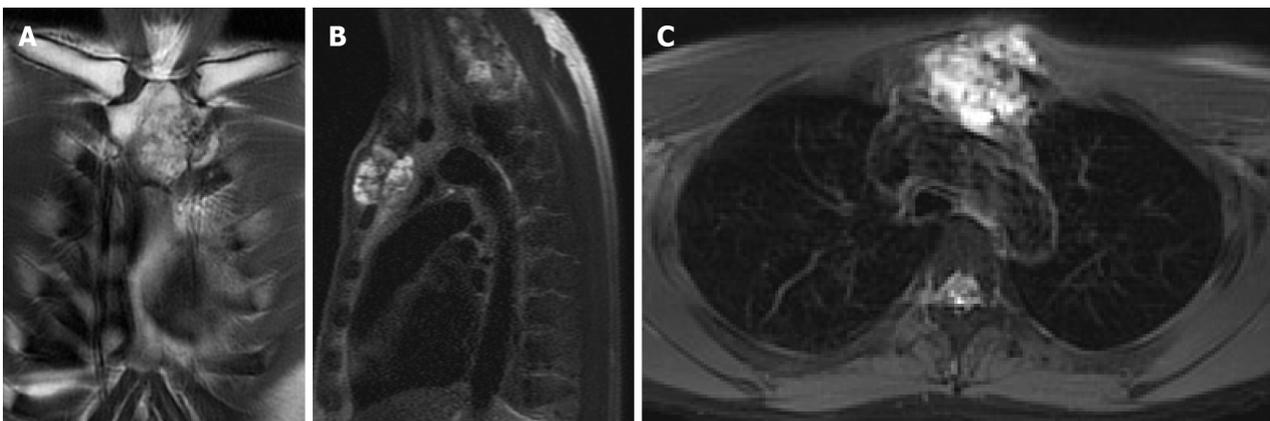


Figure 4 Focal ill-defined bony mass of the sternum with cortical destruction and periosteal reaction. A-C: Magnetic resonance imaging with (A) coronal T2-weighted scan, (B) sagittal fat-suppressed T2-weighted scan, and (C) axial fat-suppressed T2-weighted scan.

TREATMENT

The patient was kept in a supine position and surgery was performed under general anesthesia. After a routine disinfection procedure, a T-shaped incision was made so as to expose the sternum and bilateral sternoclavicular joint. Radical *en bloc* resection of the medial part of the left clavicle, manubrium, and medial part of the left first and second ribs were performed. Safe margins were confirmed by intraoperative frozen section. Reconstruction began with bilateral clavicle fixation, which was performed using a J-shaped locking plate (DePuy Synthes Comp., Zuchwil, Switzerland) with three screws placed on either side of the clavicle. Then, polymethyl methacrylate (PMMA) medium viscosity bone cement (DePuy Inc., Warsaw, IN, United States) was introduced for sternum reconstruction. The cement curing process was divided into four stages: Mixing, sticky/waiting, working, and hardening^[16]. After the defect size was carefully measured, the PMMA was remodeled to meet the shape of the manubrium during the working stage. Kirschner wires (K wires) were inserted into the cement spacer, creating holes for further suture anchoring (Figure 7), following which 1-0 Ethibond sutures (Ethicon, Somerville, NJ, United States) were passed through the pectoralis major fascia, medial portion of the clavicle, the J-shaped locking plate, and sternum body (Figure 7). The polypropylene mesh (Marlex, Bard Cardiosurgery, Billerica, MA, United States) was first placed over the mediastinum for protection, and the cement spacer was then introduced into the desire location. The



Figure 5 Gross specimen of the resected tumor showing a 6.5 cm × 6.0 cm × 5.0 cm mass with a clean resected margin as confirmed by frozen section. The tumor comprised hyaline cartilage.

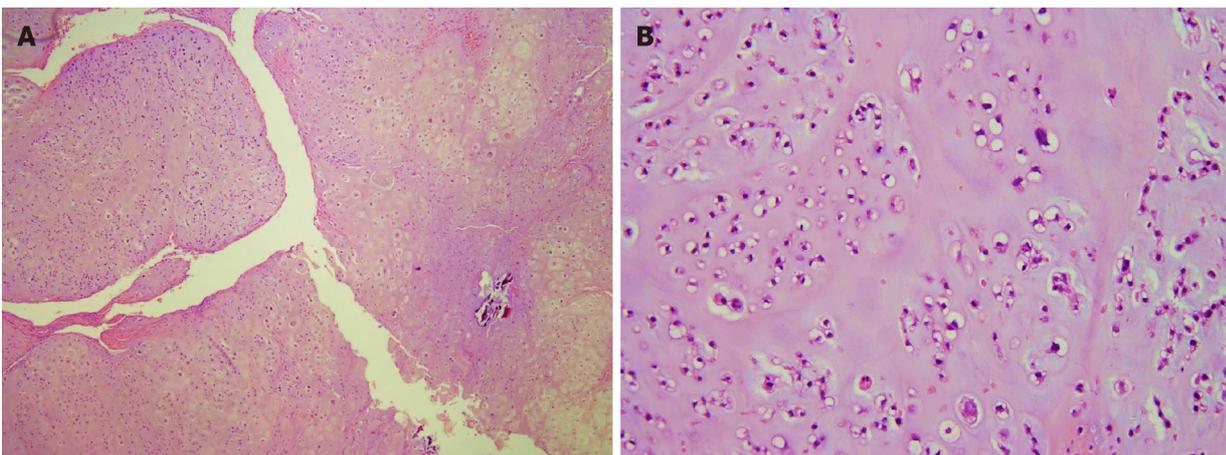


Figure 6 Pathological images. A and B: Low power (A, 40 ×) and high power (B, 200 ×) histopathology pictures of chondrosarcoma showing hyaline cartilage matrix and chondrocytes in lacunae.

Ethibond sutures passing through the spacer were tightened, ensuring the stability of the thoracic cage. Eventually, the soft tissue and skin were sutured layer by layer. The estimated blood loss was 150 mL.

OUTCOME AND FOLLOW-UP

The postoperative course was uneventful, and the patient was discharged 1 wk after surgery without any skin-related or respiratory complications. At the 1-year follow-up, chest radiography showed a solid chest with a good shape. CT revealed the absence of local tumor recurrence and stable fixation of the sternoclavicular joint (Figure 8). There was no evidence of infection, peri-implant fracture, screw loosening, or foreign body rejection. The patient's functional scores, including the Constant Score (CS), Nottingham Clavicle Score (NCS), and Oxford Shoulder Score (OSS), were well-documented^[7]. The CS was 66 before surgery and 85 at the 1-year postoperative follow-up. The NCS improved from 74 to 94, and the OSS showed some advancement, from 44 to 46. The clinical results demonstrated improvements in the patient's quality of life, with the absence of pain or substantial functional disabilities. Table 1

Table 1 Case report timeline

Complaint/investigations	Details
Presenting symptoms	Dull pain and protruding mass for 3 mo; Nocturnal pain; Mass gradually increased in size; Overhead arm elevation limitation
CT	Focal osteoblastic change in sternum manubrium region with bony exostosis with adjacent soft tissue calcification mass
PET-CT	Mass with hypermetabolic activity over the upper sternum
Bone scintigraphy	Focal increased uptake over the upper sternum
MRI	Focal ill-defined bony mass of the sternum with cortical destruction and periosteal reaction
Biopsy	Hypercellular mass with groups of neoplastic chondrocytes and extensive chondroid matrix component; Tumor cells with enlarged hyperchromatic nuclei and occasional binucleation; Some bony fragments are also present; Immunohistochemical positivity for S100 positive and focal positivity for IDH-1
Surgical intervention	Radical tumor resection followed by chest wall reconstruction with a locking plate and cement spacer; Pathology suggested grade II chondrosarcoma
Admission course	The patient was discharged 1 wk after the surgery without complication
Postoperative 1-year follow-up	1-yr follow-up: Improved CS, NSS and OSS; No evidence of local recurrence; Further consecutive follow-up needed

CT: Computed tomography; PET-CT: Positron emission tomography-computed tomography; MRI: Magnetic resonance imaging; CS: Constant Score; NCS: Nottingham Clavicle Score; OSS: Oxford Shoulder Score.

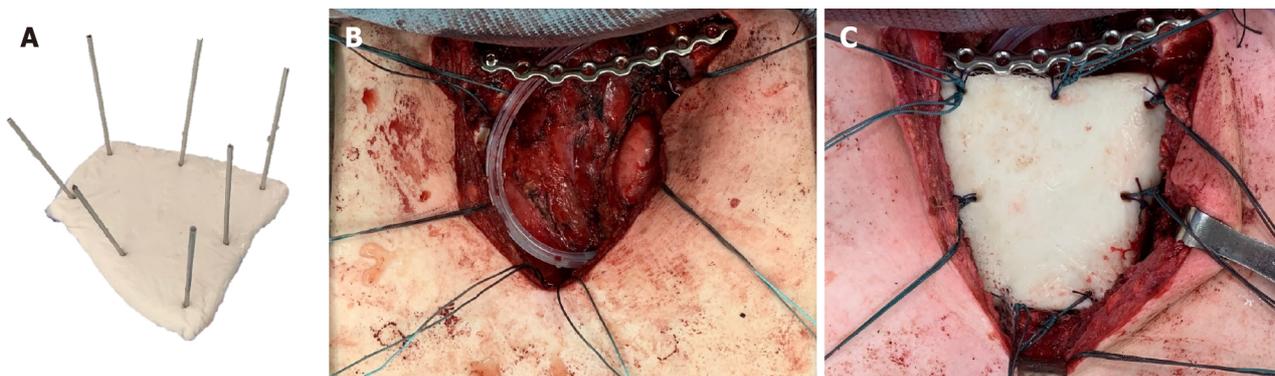


Figure 7 Intraoperative photos demonstrating the shaping of bone cement spacer for the sternum. A: We measured the defect size carefully, remodeled the polymethyl methacrylate to meet the shape of manubrium, and inserted Kirschner wire creating holes for anchoring sutures; B: Mesh placement over the mediastinum to prevent cement spacer from direct contact with the surrounding musculature and major blood vessels; C: Ethibond sutures passing through the spacer anchoring surrounding bony structures, muscles, and the J-shaped locking plate.

summarizes the treatment timeline of the patient.

DISCUSSION

To the best of our knowledge, our report presents a rare case of chondrosarcoma invading the manubrium and bilateral sternoclavicular joint. The patient underwent tumor resection and chest wall reconstruction using a cement spacer with improved clinical and radiological results.

Chondrosarcomas are hyaline-producing tumors that commonly arise in the axial and proximal appendicular skeleton. They are commonly found in the pelvis, proximal femur, proximal humerus and proximal tibia, but rare cases of chondrosarcoma in the patella and scapula have also been reported^[1,18]. The disease’s clinical presentation may vary depending on the tumor grade. Patients with low-grade chondrosarcoma may present with large tumors before medical assistance is sought, while those with high-grade chondrosarcoma tend to experience worsening pain or pathologic fractures in association with scalloping and cortical destruction^[19].

As chondrosarcomas are resistant to chemotherapy and radiotherapy, wide surgical resection is the gold standard for treatment. Local recurrence is more commonly

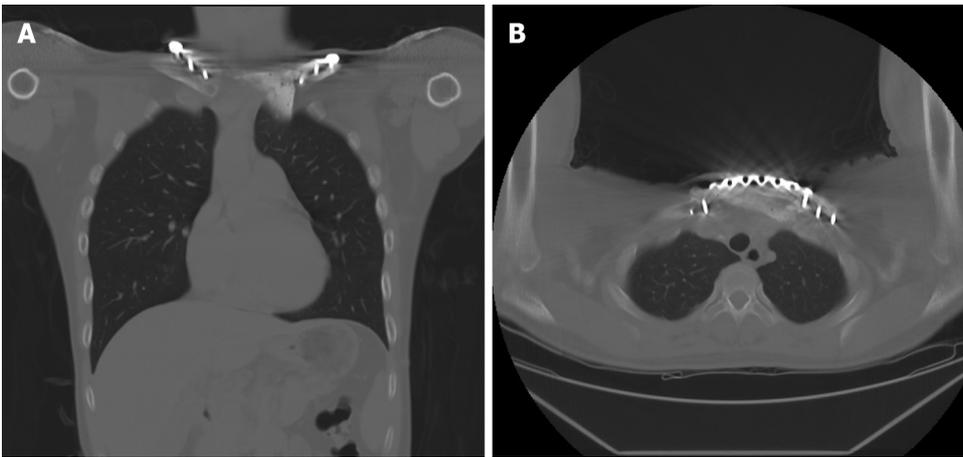


Figure 8 Coronal and axial views of computed tomography at 1-year follow-up revealing absence of local tumor recurrence. A: Coronal; B: Axial.

observed than distant metastasis in such settings, while inadequate excision margins are important risk factors for local recurrence development. Tumor histological grade, extracompartmental spread, and local recurrence are important factors that affect the survival associated with chondrosarcoma. The 10-year survival rates were reported to be 89% for grade 1, 53% for grade 2, and 38% for grade 3 chondrosarcoma^[20]. Another population-based Scandinavian Sarcoma Group study revealed a 10-year survival rate of 67% for treated patients (92% after wide resection and 47% following intralesional resection)^[6].

Chondrosarcoma of the sternum is rarely encountered by orthopedic surgeons. The performance of complete tumor resection without damage to the surrounding major organs and vessels, and reconstruction following tumor resection is challenging. Our study sought to report the preliminary clinical results associated with reconstruction performed using familiar, easily-available, and durable materials. PMMA bone cement is known for its strength against compression and bending, which is vital in the construction of a solid and stable thoracic cage.

Currently, there is no guideline regarding the absolute indication for chest wall reconstruction. However, most previous studies indicated that a chest wall defect larger than 5 cm in size or containing four or more ribs would benefit from chest wall reconstruction^[8-10,21]. Several studies have demonstrated various chest wall reconstruction methods in the fields of cardiac and thoracic surgery. Gao *et al.*^[13] reported on the use of titanium sternal fixation systems for reconstruction, while Ma *et al.*^[4] performed sternal reconstruction with 3-dimensional (3D) custom-made prostheses. Metal prosthesis carries the advantage of establishing adequate chest wall stability, but there are some limitations regarding the use of metal prosthesis including prosthesis dislocation, infection, or inappropriate sizing. The 3D custom made prosthesis provides a reliable option for reconstruction with perfect shape matching but is time consuming, expensive, and not readily-available in every institution. Allograft transplantation is also discussed in the literature with better biological effect in reconstruction but the source is limited and the risk of disease transmission should also be taken into consideration^[10].

Some reports also advocate the performance of biological reconstruction using the rectus abdominus flap, omental flap, latissimus dorsi flap, or free flap for soft tissue coverage^[22-25]. The advantage of using flap coverage is its ability to incorporate into a patient's native tissue by revascularization and tissue regeneration. However, there are some surgery-related complications that need to be addressed. Ventral herniation and prolonged ileus were previously found after abdominus flap or omental flap surgery^[22]. Shoulder extension endurance and adduction deficits and short-term reductions in the arm strength following latissimus dorsi flap transfer have been noted^[23]. Free flap reconstruction, which is associated with a relatively low rate of donor site complications, is technically demanding and requires frequent inspections and anticoagulation therapy administration after surgery^[24,25].

The strengths of our reconstruction technique are as follows. It is reliable and provides adequate chest wall stability. In addition, the low cost is better tolerated by the patient. Furthermore, the procedure is not time-consuming and most orthopedic surgeons are familiar with. Finally, cement is readily-available and the moldability

also offers the advantage of better size-matching, providing personalized treatment. We believe the technique, which yielded promising results, may serve as an alternative in cases such as ours.

Our study has some limitations. First, the shape of handmade cement spacer may not be superior to 3D custom-made prostheses and this is not a biological reconstruction. Second, the maximal strength of PMMA bone cement against chest wall trauma requires further biomechanical study. Moreover, it is a case report with a 1-year follow-up period. Longer follow-up durations, for the monitoring of possible local recurrence or distal metastasis, are still required. Finally, there is a need for large series with control groups to ensure the reproducibility of our findings, and to confirm the radiological and functional outcomes associated with the technique that we used as well.

CONCLUSION

Bilateral sternoclavicular joint fixation with a locking plate along with PMMA cement reconstruction of the sternum is a safe and cost-effective method through which chest cavity stabilization can be achieved. The study provides a surgical alternative, from the orthopedic perspective, in the management of chest wall chondrosarcoma, with good clinical functional scores and the absence of local recurrence on imaging.

REFERENCES

- 1 **Qiang S**, Ma XN, Wang HW, Lv SC. Scapula chondrosarcoma: A case report. *Medicine (Baltimore)* 2019; **98**: e15388 [PMID: [31027132](#) DOI: [10.1097/MD.00000000000015388](#)]
- 2 **Liu S**, Zhou X, Song A, Huo Z, Wang Y, Liu Y. Surgical treatment of metastatic mesenchymal chondrosarcoma to the spine: A case report. *Medicine (Baltimore)* 2020; **99**: e18643 [PMID: [32000368](#) DOI: [10.1097/MD.00000000000018643](#)]
- 3 **Liu ZC**, Zhao H. Titanium internal fixation system used for sternum reconstruction after resection of chondrosarcoma. *Chin Med J (Engl)* 2010; **123**: 2621-2622 [PMID: [21034640](#)]
- 4 **Ma XL**, Wang DB, Ma JX, Wang Y, Sun L, Lu B, Zhao XW, Li F, Fan ZR, Han B, Bai HH, Yang BC, Jiang X, Tian AX, Dong BC, Du YR. Custom-made Prosthesis for Reconstruction after Radical Resection for Chondrosarcoma of Manubrium. *Orthop Surg* 2018; **10**: 272-275 [PMID: [30152608](#) DOI: [10.1111/os.12388](#)]
- 5 **Burt M**, Fulton M, Wessner-Dunlap S, Karpel M, Huvos AG, Bains MS, Martini N, McCormack PM, Rusch VW, Ginsberg RJ. Primary bony and cartilaginous sarcomas of chest wall: results of therapy. *Ann Thorac Surg* 1992; **54**: 226-232 [PMID: [1637209](#) DOI: [10.1016/0003-4975\(92\)91374-i](#)]
- 6 **Widhe B**, Bauer HC; Scandinavian Sarcoma Group. Surgical treatment is decisive for outcome in chondrosarcoma of the chest wall: a population-based Scandinavian Sarcoma Group study of 106 patients. *J Thorac Cardiovasc Surg* 2009; **137**: 610-614 [PMID: [19258076](#) DOI: [10.1016/j.jtcvs.2008.07.024](#)]
- 7 **Lequaglie C**, Massone PB, Giudice G, Conti B. Gold standard for sternectomies and plastic reconstructions after resections for primary or secondary sternal neoplasms. *Ann Surg Oncol* 2002; **9**: 472-479 [PMID: [12052759](#) DOI: [10.1007/BF02557271](#)]
- 8 **Chapelier AR**, Missana MC, Couturaud B, Fadel E, Fabre D, Mussot S, Pouillart P, Darteville PG. Sternal resection and reconstruction for primary malignant tumors. *Ann Thorac Surg* 2004; **77**: 1001-1006; discussion 1006 [PMID: [14992915](#) DOI: [10.1016/j.athoracsur.2003.08.053](#)]
- 9 **Girotti P**, Leo F, Bravi F, Tavecchio L, Spano A, Cortinovis U, Nava M, Pastorino U. The "rib-like" technique for surgical treatment of sternal tumors: lessons learned from 101 consecutive cases. *Ann Thorac Surg* 2011; **92**: 1208-1215; discussion 1215 [PMID: [21958766](#) DOI: [10.1016/j.athoracsur.2011.05.016](#)]
- 10 **Seder CW**, Rocco G. Chest wall reconstruction after extended resection. *J Thorac Dis* 2016; **8**: S863-S871 [PMID: [27942408](#) DOI: [10.21037/jtd.2016.11.07](#)]
- 11 **Chaudhry Iu**, Alhajji Z, Aldulajjan F, Mutairi H, Amr SS. Manubrioclavicular and Manubriosternal Reconstruction After Radical Resection for Chondrosarcoma of Manubriosternum: A Modified Surgical Technique. *Ann Thorac Surg* 2015; **99**: e137-e139 [PMID: [26046904](#) DOI: [10.1016/j.athoracsur.2015.02.119](#)]
- 12 **Aprile V**, Korasidis S, Crisci R, Ambrogi MC. Chest wall reconstruction with a novel titanium mesh after partial sternectomy for chondrosarcoma. *Interact Cardiovasc Thorac Surg* 2020; **30**: 149-150 [PMID: [31873742](#) DOI: [10.1093/icvts/ivz214](#)]
- 13 **Gao E**, Li Y, Zhao T, Guo X, He W, Wu W, Zhao Y, Yang Y. Reconstruction of anterior chest wall: a clinical analysis. *J Cardiothorac Surg* 2018; **13**: 124 [PMID: [30526640](#) DOI: [10.1186/s13019-018-0810-x](#)]
- 14 **Chen C**, Huang X, Chen M, Yu F, Yin B, Yuan Y. Surgical management of a giant sternal chondromyxoid fibroma: a case report. *J Cardiothorac Surg* 2015; **10**: 178 [PMID: [26615403](#) DOI: [10.1186/s13019-015-0178-0](#)]

- [10.1186/s13019-015-0370-2](https://doi.org/10.1186/s13019-015-0370-2)
- 15 **Dell'Amore A**, Cassanelli N, Dolci G, Stella F. An alternative technique for anterior chest wall reconstruction: the sternal allograft transplantation. *Interact Cardiovasc Thorac Surg* 2012; **15**: 944-947 [PMID: [22990634](https://pubmed.ncbi.nlm.nih.gov/22990634/) DOI: [10.1093/icvts/ivs411](https://doi.org/10.1093/icvts/ivs411)]
 - 16 **Vaishya R**, Chauhan M, Vaish A. Bone cement. *J Clin Orthop Trauma* 2013; **4**: 157-163 [PMID: [26403875](https://pubmed.ncbi.nlm.nih.gov/26403875/) DOI: [10.1016/j.jcot.2013.11.005](https://doi.org/10.1016/j.jcot.2013.11.005)]
 - 17 **Charles ER**, Kumar V, Blacknall J, Edwards K, Geoghegan JM, Manning PA, Wallace WA. A validation of the Nottingham Clavicle Score: a clavicle, acromioclavicular joint and sternoclavicular joint-specific patient-reported outcome measure. *J Shoulder Elbow Surg* 2017; **26**: 1732-1739 [PMID: [28601491](https://pubmed.ncbi.nlm.nih.gov/28601491/) DOI: [10.1016/j.jse.2017.03.036](https://doi.org/10.1016/j.jse.2017.03.036)]
 - 18 **Ye C**, Luo Z, Zeng J, Dai M. Chondrosarcoma of the patella: A case report. *Medicine (Baltimore)* 2017; **96**: e8049 [PMID: [28906396](https://pubmed.ncbi.nlm.nih.gov/28906396/) DOI: [10.1097/MD.00000000000008049](https://doi.org/10.1097/MD.00000000000008049)]
 - 19 **Riedel RF**, Larrier N, Dodd L, Kirsch D, Martinez S, Brigman BE. The clinical management of chondrosarcoma. *Curr Treat Options Oncol* 2009; **10**: 94-106 [PMID: [19238552](https://pubmed.ncbi.nlm.nih.gov/19238552/) DOI: [10.1007/s11864-009-0088-2](https://doi.org/10.1007/s11864-009-0088-2)]
 - 20 **Fiorenza F**, Abudu A, Grimer RJ, Carter SR, Tillman RM, Ayoub K, Mangham DC, Davies AM. Risk factors for survival and local control in chondrosarcoma of bone. *J Bone Joint Surg Br* 2002; **84**: 93-99 [PMID: [11837841](https://pubmed.ncbi.nlm.nih.gov/11837841/) DOI: [10.1302/0301-620x.84b1.11942](https://doi.org/10.1302/0301-620x.84b1.11942)]
 - 21 **Mahabir RC**, Butler CE. Stabilization of the chest wall: autologous and alloplastic reconstructions. *Semin Plast Surg* 2011; **25**: 34-42 [PMID: [22294941](https://pubmed.ncbi.nlm.nih.gov/22294941/) DOI: [10.1055/s-0031-1275169](https://doi.org/10.1055/s-0031-1275169)]
 - 22 **Daigeler A**, Simidjiiska-Belyaeva M, Drücke D, Goertz O, Hirsch T, Soimaru C, Lehnhardt M, Steinau HU. The versatility of the pedicled vertical rectus abdominis myocutaneous flap in oncologic patients. *Langenbecks Arch Surg* 2011; **396**: 1271-1279 [PMID: [21779830](https://pubmed.ncbi.nlm.nih.gov/21779830/) DOI: [10.1007/s00423-011-0823-6](https://doi.org/10.1007/s00423-011-0823-6)]
 - 23 **Glassey N**, Perks GB, McCulley SJ. A prospective assessment of shoulder morbidity and recovery time scales following latissimus dorsi breast reconstruction. *Plast Reconstr Surg* 2008; **122**: 1334-1340 [PMID: [18971716](https://pubmed.ncbi.nlm.nih.gov/18971716/) DOI: [10.1097/PRS.0b013e3181881ffe](https://doi.org/10.1097/PRS.0b013e3181881ffe)]
 - 24 **Fischer S**, Klinkenberg M, Behr B, Hirsch T, Kremer T, Hernekamp F, Kolbenschlag J, Lehnhardt M, Kneser U, Daigeler A. Comparison of donor-site morbidity and satisfaction between anterolateral thigh and parascapular free flaps in the same patient. *J Reconstr Microsurg* 2013; **29**: 537-544 [PMID: [23982858](https://pubmed.ncbi.nlm.nih.gov/23982858/) DOI: [10.1055/s-0033-1351394](https://doi.org/10.1055/s-0033-1351394)]
 - 25 **Klinkenberg M**, Fischer S, Kremer T, Hernekamp F, Lehnhardt M, Daigeler A. Comparison of anterolateral thigh, lateral arm, and parascapular free flaps with regard to donor-site morbidity and aesthetic and functional outcomes. *Plast Reconstr Surg* 2013; **131**: 293-302 [PMID: [23357991](https://pubmed.ncbi.nlm.nih.gov/23357991/) DOI: [10.1097/PRS.0b013e31827786bc](https://doi.org/10.1097/PRS.0b013e31827786bc)]



Published by **Baishideng Publishing Group Inc**
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
Telephone: +1-925-3991568
E-mail: bpgoffice@wjgnet.com
Help Desk: <https://www.f6publishing.com/helpdesk>
<https://www.wjgnet.com>

