İstanbul Med J 2024; 25(3): 185-9
DOI: 10.4274/imj.galenos.2024.56898

Sonar Mining of Deeply Located Foreign Bodies in the Musculoskeletal System

Mehmet Akif Çaçan[1], Murat Birinci[1], Kadir Uzel[1], Mehmet Kürşat Yılmaz[1], Bahattin Kemah[2], Ali İhsan Tuğrul[3]

[1]Medipol Mega University Hospital, Clinic of Orthopedics and Traumatology, İstanbul, Turkey
[2]University of Heath Sciences Turkey, Ümraniye Training and Research Hospital, Clinic of Orthopaedics and Traumatology, İstanbul, Turkey
[3]Konya Beyhekim Training and Research Hospital, Clinic of Orthopedics and Traumatology, Konya, Turkey

ABSTRACT

Introduction: Foreign body (FB) injuries constitute an important part of admission to emergency and orthopedic clinics in daily practice. The localization and removal of FBs can be difficult. Ultrasound (USG) plays an important role in the localization of FBs. In this study, we aimed to present the results of patients who underwent US-guided FB extraction.

Methods: Fifty-seven patients who were admitted to the emergency service and orthopedic outpatient clinic due to FB trauma to soft tissue were retrospectively evaluated. USG-guided removal was performed under local anesthesia. The number, size, shape, structure, distance to the skin, and integrity of the FB were determined using USG guidance. Patient satisfaction was evaluated with Roles-Maudsley score.

Results: The mean duration of surgery was 7 min (range; 5 to 20 minutes), and the mean incision size was 11 mm (range; 5 to 25 mm). Forty-seven of the patients underwent an outpatient procedure and were discharged on the same day. No postoperative complications were observed. Fifty one of 57 (89.5%) were very satisfied with the surgery.

Conclusion: Consequently, USG-guided FB extraction is a safe, fast, and comfortable option for the patient and the physician. Orthopedic physicians should receive USG training starting from their assistantship, and its use in daily practice should be increased.

Keywords: Ultrasound, soft tissue, foreign body

Introduction

Foreign body (FB) injuries constitute an important part of admission to emergency and orthopedic clinics in daily practice. While most of them are superficial and palpable, some are located deeply. FB that penetrates the soft tissue in the musculoskeletal system may remain asymptomatic for a long time, as well as cause different symptoms and complications. Pain, abscess formation, tendon irritation, neurovascular damage, inflammatory reaction, and necrotizing fasciitis are some of the symptoms (1-4).

Radiographs can be useful for localization and are often used as part of initial evaluation. Radiopaque objects such as metals, shrapnel, and glass fragments can be seen on plain radiographs; radiolucent objects such as wood, splinters, and plastics may not be visible (5). The localization and removal of deeply located and radiolucent FBs that cannot be palpated can be difficult. Ultrasound (USG) plays an important role in the localization of these FB (6).

Although superficial, palpable FBs can be easily removed under emergency and outpatient clinic conditions, deep penetrating and non-palpable FBs may need to be extracted under operating room conditions (7).

Fluoroscopy is also frequently used for the localization and removal of radiopaque objects. The patient and surgical team may be exposed to radiation (8). The aim of this study was to present the results of patients who underwent USG-guided FB removal.

Methods

Sixty-one consecutive patients (34 men, 27 women) who were admitted to the emergency service or orthopedic outpatient clinic due to FB trauma to soft tissue were evaluated. Four patients were lost during follow-up. In 53 of the 57 remaining patients, the reason for admission was persistent pain, whereas in three patients, it was the feeling of discomfort caused by the presence of FB. In one patient, FB was removed for forensic reasons. Before the intervention, 44 patients had X-ray imaging. However, X-ray imaging was not available for 13 patients. Among those with X-ray imaging, three underwent computed tomographies (CT) as supplementary imaging, while one patient without X-ray imaging underwent magnetic resonance imaging (MRI).

Address for Correspondence: Murat Birinci MD, Medipol Mega University Hospital, Clinic of Orthopedics and Traumatology, İstanbul, Turkey
Phone: +90 532 423 31 88 **E-mail:** drmuratbirinci@gmail.com **ORCID ID:** orcid.org/0000-0002-6268-9910

Cite this article as: Çaçan MA, Birinci M, Uzel K, Yılmaz MK, Kemah B, Tuğrul Aİ. Sonar Mining of Deeply Located Foreign Bodies in the Musculoskeletal System. İstanbul Med J. 2024; 25(3): 185-9

Received: 27.02.2024
Accepted: 24.05.2024

©Copyright 2024 by the University of Health Sciences Turkey, İstanbul Training and Research Hospital/İstanbul Medical Journal published by Galenos Publishing House. Licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 (CC BY-NC-ND) International License

Diagnostic USG was performed by the radiologist in all patients, and USG-guided surgery was recommended for patients with confirmed FB presence. The number, size, shape, structure, distance to the skin, and integrity of the FB were determined with USG-guidance (Table 1).

FB that could not be palpated at a depth of at least 10 mm, localized in the lower or upper extremities were included in the study. Objects that are superficial (10 mm > depth) and/or felt by palpation excluded from the study.

The surgery was performed under sterile conditions in emergency or outpatient intervention rooms using local anesthesia in 45 patients who could tolerate it. For 12 patients who either did not want or could not tolerate local anesthesia, the procedure was conducted in the operating room. Among these patients, sedation was administered to seven, spinal anesthesia to three, and general anesthesia to two. Post-operative control X-rays were taken for patients who underwent surgery due to radiopaque FB; however, no examination was requested for those with radiolucent FB. After the intervention, patients were monitored until wound healing and suturing was performed. Satisfaction assessment was conducted using the Roles-Maudsley questionnaire during the second month of follow-up (Table 2) (9).

First of all, the localization of the FB was visualized by USG. The surgical area was sterilely prepped with a povidone iodine solution. The USG probe was covered with a sterile sheath. Local anesthesia was applied at the site of FB. Then, the guide needle tip was sent to the FB using USG guidance (Figure 1). Without removing the guide needle, a minimal incision was made at the needle insertion point into the skin. Blunt dissection was observed along the needle trace, and the FB was reached. The FB is held along its long axis with the help of a clamp or grasper and then removed. Fluoroscopy was not used in any of the cases (Figure 2, 3).

High-resolution USG was performed by a radiologist with an experience of more than 10 years in USG and two orthopedic surgeons with an experience of 3 years (M.A.Ç., B.K.). The study was conducted using a GE Logiq P5 USG machine.

This study was approved by the İstanbul Medipol University Ethical Committee approval number: 190, date: 18.02.2021). All patients provided written informed consent.

Statistical Analysis

Statistical analysis was performed using SPSS for Windows version 29.0 (IBM Corp, Armonk, NY, USA). Descriptive statistics, including means, minimums, and maximums, were examined to gain insights into the central tendency and variability of the variables under investigation.

Results

The mean age of the patients was 22 (range; 2 to 62). Twenty-seven of the patients were women, and 30 were men. The mean time between the penetration of the FB and surgical intervention was 74 days (range; 1 day to 2 years). Thirteen patients developed abscesses around the FB. The area where the FB penetrated was the foot in 26 patients, hand in 19, knee in four, cruris in three, elbow in two, forearm in one, hip in one, and thigh in one (Table 1).

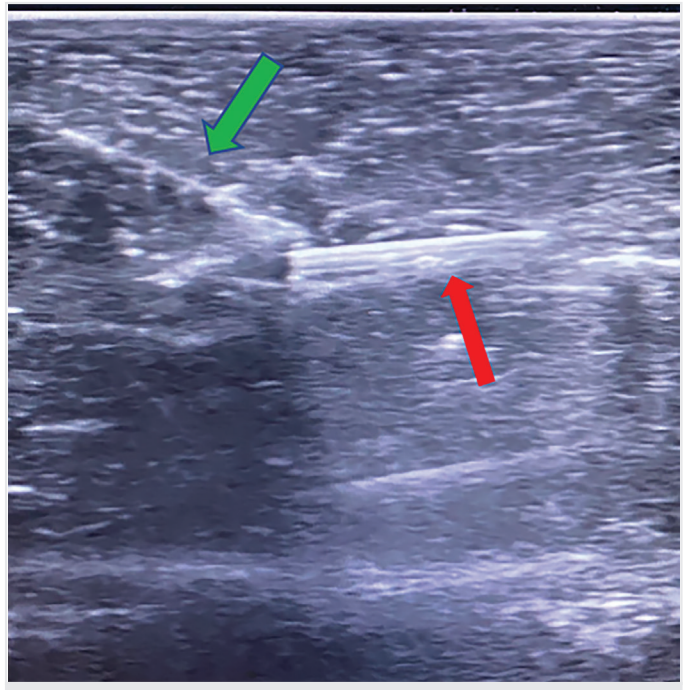

Figure 1. Foreign body (needle) indicated by a red arrow. Guide needle shown with green arrow

Table 1. Characteristics of the foreign bodies according to localizations

Localization	n (%)	Width (mm)	Length (mm)	Depth (mm)	Time (min)	Incision (mm)
Foot	26 (45.6)	2.7 (0.8-15)	16.5 (3-27)	17.3 (10-35)	7.5 (5-20)	11 (6-25)
Hand	19 (33.3)	1.8 (0.7-3)	10 (2-40)	11.8 (10-15)	6.7 (5-15)	8.4 (6-10)
Knee	4 (7)	1.4 (0.7-3)	18.2 (3-25)	23.7 (15-30)	9.5 (5-15)	16.2 (5-25)
Cruris	3 (5.2)	1.3 (1-2)	16 (3-40)	33 (30-40)	7 (5-10)	13 (8-20)
Elbow	2 (3.5)	0.9 (0.8-1)	14 (10-18)	25 (20-30)	8 (5-11)	14 (8-20)
Forearm	1 (1.8)	2	6	30	5	8
Hip	1 (1.8)	1	12	7	11	20
Thigh	1 (1.8)	5	11	40	15	25
Total	57 (100)	2.2	13.9	18	7.5	11.1

n: Number, mm: Milimeter, min: Minute(s)

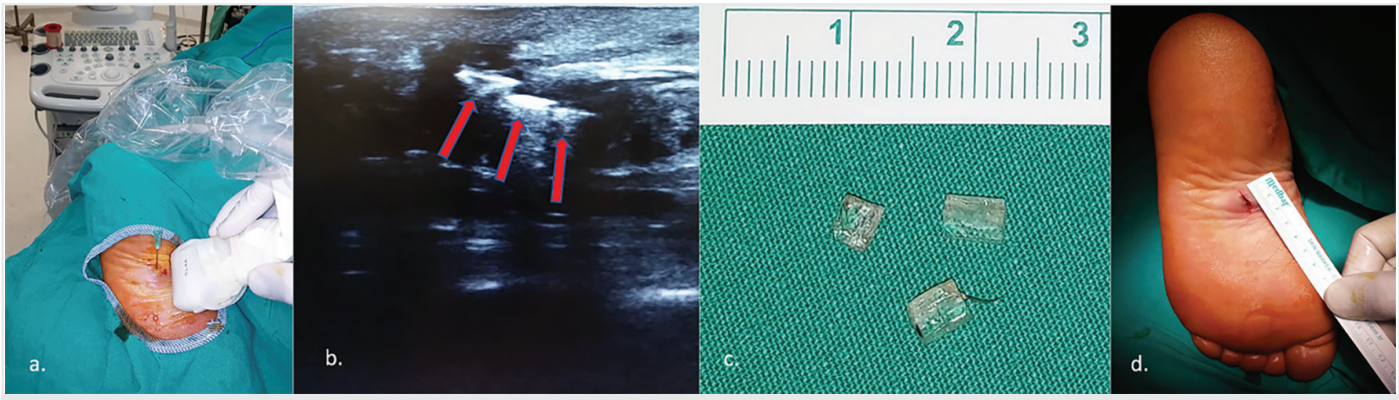

Figure 2. Ultrasound-assisted foreign body (glass pieces) removal from the left foot plantar area. (a, b) Localization of glass pieces under USG guidance (red arrows show the glass pieces), (c) Removed glass pieces, (d) 15 mm skin incision. (Written informed consent is taken from the patient)

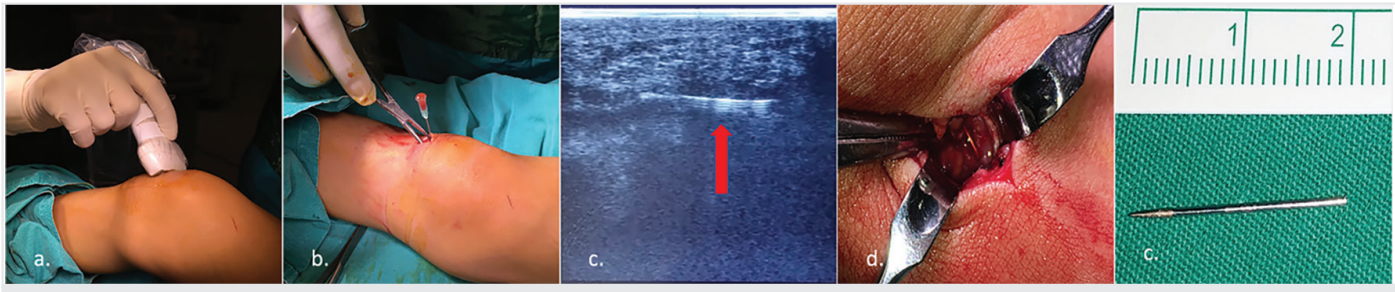

Figure 3. Ultrasound-assisted foreign body (needle) removal from the anterior part of the knee, (a, b) Localization of needle under USG guidance, (c) Red arrow show the needle, (d) Approximately 13 mm skin incision, (e) Removed needle. (Written informed consent is taken from the patient)

Table 2. Roles-Maudsley score

	Point	Interpretation
Excellent	1	No pain, full activity
Good	2	Occasional discomfort, full activity
Fair	3	Some discomfort after prolonged activity
Poor	4	Pain-limiting activity

Three glass pieces were extracted from the foot of one patient (Figure 2). They were considered a single piece because of their close localization to each other. All FB were successfully removed. Local anesthesia was preferred mainly for the patients. Local anesthesia was applied to 45 patients, sedation to seven, spinal anesthesia to three, and general anesthesia to two patients.

The average depth of FB was 18 mm (range; 10 to 40 mm), and the average size was 2x14 mm (range; 2x2 mm to 15x25 mm). While 38 of the FB were metallic (sewing needle, bullet core, iron burr), 11 were wood (piece of wood, thorn, toothpick) and 8 of them were glass.

The mean duration of surgery was 7 minutes (range; 5 to 20 minutes), and the mean incision size was 11 mm (range; 5 to 25 mm). Forty-seven of the patients underwent an outpatient procedure and were discharged on the same day. Nine patients were discharged after hospitalization for one night and one patient for two nights. For patients with abscess, postoperative antibiotherapy was initiated. No postoperative complications were observed in any patient during follow-up period. At second month follow up, 51 patients (89.5%) were very satisfied (excellent) with the surgery, and six (11.5%) patients were satisfied (good).

Discussion

Clinical examination may be insufficient for localization and removal of some FBs. Additional attempts may be required to locate and remove deeply located FBs with granulation tissue surrounding them. Under USG, 57 non-palpable FBs were removed from the patients.

On one hand, some FBs penetrating the body may not show any symptoms; on the other hand, some may present with symptoms such as pain, tingling, hematoma, abscess formation, numbness, and loss of motor function due to nerve compression and anxiety (2,7). Although the main complaint of the patients in our study was pain, three patients requested extraction because they wanted to get rid of the feeling of a FB in the body, although there were no clinical symptoms.

Plain radiography is the preferred imaging modality for patients with FB penetration. Although plain radiographs are sufficient to show the presence of most FB, advanced imaging methods are needed to determine the presence and localization of materials such as plastics and wood that are not radiopaque. CT and MRI can also be used for diagnosis. Because they are expensive test methods, they are not the first choice and are not indicated for every FB (10). For example, most metallic objects are contraindicated for MRI (6). USG is an inexpensive imaging method with high sensitivity and specificity. Sonography has a reported sensitivity of 95% for detecting FB. In addition, it provides real-time intervention (11). In our series, 45 patients had previously

undergone imaging. For the two cases in which glass was penetrated, CT was requested, and in one case, MRI was used for detecting FB.

Hyperechoic appearance and shadowing are US findings that suggest a FB. This tool can be used for preoperative FB localization and as a guide for real-time intervention. Different methods for removal of FB are defined before (12-14). In daily practice, the removal of deeply located radiopaque materials is often performed under fluoroscopy in operating rooms. Although the extraction of some objects can be done easily with fewer fluoroscopic imaging procedures, a long operation time, excessive labor, and exposure to high radiation volumes (fluoroscopy) may be required to remove some FBs (8). This may lead to increased incision size and further soft tissue damage. During the extraction of FB located close to the vessels and nerves, these structures may also be damaged. The use of USG has previously been described in the literature (15-17). Our technique can also be considered a modified version of these previously described methods. In this technique, the localization of the FB is first determined by USG. Then, the FB is reached with a relatively small incision with a guide needle tip, and the FB is removed. Thus, the surrounding tissues are minimally damaged. Thus, it is possible to remove objects in the neighboring areas of the vascular nerve without damaging these structures. No major vascular or neurological complications occurred in our series. Only one patient experienced numbness around the incision side in the second week. On the second month, he stated his complications were completely recovered. Two months after surgery, all patients had satisfactory outcomes.

One of the difficulties of this method is that performing USG requires experience (18). In our study, the measurements were conducted by an experienced radiologist, and interventions were performed by two orthopedic surgeons with three years of experience using USG.

Complications such as tendon irritation, neuroma, and neuropathy due to FB remaining in the body for a long time have been reported in the literature. In addition, objects that can move like a needle tip may migrate to surrounding tissues and cause tissue irritation (19). In our study, we observed that a broken sewing needle penetrating the sole of the foot migrated between the metatarsals within two weeks. After localization with USG, the needle tip was extracted through an incision without damaging the tendon and vascular nerve package. Neurovascular deficit was not observed in the patient's follow-up period.

The monthly radiation exposure of an orthopedic resident doctor in trauma rotation was 79 mrem/month, and an orthopedic surgeon dealing with trauma and deformity was reported to be exposed to radiation of 53 mrem/month (20). One of the most important advantages of USG-guided procedures is that no need for fluoroscopy. During the procedure, the patient is exposed to radiation only during the first presentation and postoperative control radiographs. Thus, the amount of radiation to which both the patient and performer are exposed/to be exposed is reduced.

Another advantage of USG-guided FB removal is that it shortens the operation time and reduces the use of the operating room, thus reducing the cost. The average operating room usage fees in the United States are 35-36 dollars according to 2018 data (21). In our study, although the mean intervention duration was 7 min, only 12 of the 57 patients underwent the intervention under operating room conditions. The reasons for this are that patients do not want isolated local anesthesia, prefer a different anesthesia method, or are too young to tolerate local anesthesia.

Study Limitation

Our study also has some limitations. This was a retrospective study with a small sample size. Another significant limitation was the incomplete X-ray imaging of the 13 patients. This circumstance may have led to the oversight of the accompanying pathologies. Additionally, we did not have a control group with the same/similar traumas, which limits us from comparing our results with those of other treatment methods.

Conclusion

USG-guided FB extraction is a safe, fast, and comfortable option for patients and physicians. It should be preferred more in orthopedic practice. For this orthopedic physicians should receive USG training starting from their assistantship, and its use in daily practice should be increased. New multicenter studies involving larger sample sizes should be conducted to better demonstrate the effectiveness of this approach.

Acknowledgements: We extend our gratitude to İrem Erdil, a dedicated radiologist, for her invaluable assistance with the radiological measurements during the course of this study.

Ethics Committee Approval: This study was approved by the İstanbul Medipol University Ethical Committee approval number: 190, date: 18.02.2021).

Informed Consent: All patients provided written informed consent.

Authorship Contributions: Surgical and Medical Practices - M.A.Ç., B.K.; Concept - M.A.Ç., M.B., K.U., M.K.Y., B.K., A.İ.T.; Design - M.A.Ç., M.B., M.K.Y., B.K., A.İ.T.; Data Collection or Processing - M.A.Ç., M.B., K.U., B.K., A.İ.T.; Analysis or Interpretation - M.A.Ç., M.B., K.U., M.K.Y., A.İ.T.; Literature Search - M.A.Ç., M.B., K.U., M.K.Y., B.K.; Writing - M.A.Ç., M.B., K.U., M.K.Y., B.K.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Levine MR, Gorman SM, Young CF, Courtney DM. Clinical characteristics and management of wound foreign bodies in the ED. Am J Emerg Med. 2008; 26: 918-22.
2. Yanay O, Vaughan DJ, Diab M, Brownstein D, Brogan TV. Retained wooden foreign body in a child's thigh complicated by severe necrotizing fasciitis: a case report and discussion of imaging modalities for early diagnosis. Pediatr Emerg Care. 2001; 17: 354-5.
3. Choudhari KA, Muthu T, Tan MH. Progressive ulnar neuropathy caused by delayed migration of a foreign body. Br J Neurosurg. 2001; 15: 263-5.
4. Turker M, Basbug V, Kesik K, Turkmen F, Kacira BK, Korucu IH, et al. Evaluation of deep-seated soft tissue foreign bodies according to gender and age groups. Selcuk Med J. 2019; 1: 24-30.

5. Hunter TB, Taljanovic MS. Foreign bodies. Radiographics. 2003; 23: 731-57.

6. Mohammadi A, Ghasemi-Rad M, Khodabakhsh M. Non-opaque soft tissue foreign body: sonographic findings. BMC Med Imaging. 2011; 11: 9.

7. Zhu Q, Chen Y, Zeng Q, Zhao J, Yu X, Zhou C, et al. Percutaneous extraction of deeply-embedded radiopaque foreign bodies using a less-invasive technique under image guidance. J Trauma Acute Care Surg. 2012; 72: 302-5.

8. Müller LP, Suffner J, Wenda K, Mohr W, Rommens PM. Radiation exposure to the hands and the thyroid of the surgeon during intramedullary nailing. Injury. 1998; 29: 461-8.

9. Roles NC, Maudsley RH. Radial tunnel syndrome: resistant tennis elbow as a nerve entrapment. J Bone Joint Surg Br. 1972; 54: 499-508.

10. Flom LL, Ellis GL. Radiologic evaluation of foreign bodies. Emerg Med Clin North Am. 1992; 10: 163-77.

11. Ober CP, Jones JC, Larson MM, Lanz OI, Werre SR. Comparison of ultrasound, computed tomography, and magnetic resonance imaging in detection of acute wooden foreign bodies in the canine manus. Vet Radiol Ultrasound. 2008; 49: 411-8.

12. Uludağ A, Tosun HB, Çiçek N, Şirik M, Uludağ Ö, Atiç R. Surgical approach to foreing bodies observed in the soft tissue of extremities after injury. Dicle Med J. 2019; 46: 215-23 (Turkish).

13. Dülgeroğlu TC, MetiNeren H, Aydin E, Dülgeroğlu A. A conscious patient: taking a foreign object out with the help of a magnet: case report. Turkiye Klinikleri J Case Rep. 2016; 24: 344-7.

14. Bilgin Y, Birisik F. Retrospective analysis of puncture wounds with retained foreign bodies in the extremities requiring surgical intervention. Med-Science. 2021; 10: 416.

15. Tantray MD, Rather A, Manaan Q, Andleeb I, Mohammad M, Gull Y. Role of ultrasound in detection of radiolucent foreign bodies in extremities. Strategies Trauma Limb Reconstr. 2018; 13: 81-5.

16. Rooks VJ, Shiels WE 3rd, Murakami JW. Soft tissue foreign bodies: a training manual for sonographic diagnosis and guided removal. J Clin Ultrasound. 2020; 48: 330-6.

17. Hiremath R, Reddy H, Ibrahim J, Haritha CH, Shah RS. Soft tissue foreign body: utility of high-resolution ultrasonography. J Clin Diagn Res. 2017; 11: TC14-6.

18. Orlinsky M, Knittel P, Feit T, Chan L, Mandavia D. The comparative accuracy of radiolucent foreign body detection using ultrasonography. Am J Emerg Med. 2000; 18: 401-3.

19. Devgan A, Mudgal KC. An unusual case of foreign body knee that spontaneously migrated inside and out of the joint: arthroscopic removal. Knee Surg Sports Traumatol Arthrosc. 2007; 15: 758-60.

20. Gausden EB, Christ AB, Zeldin R, Lane JM, McCarthy MM. Tracking cumulative radiation exposure in orthopaedic surgeons and residents: what dose are we getting? J Bone Joint Surg Am. 2017; 99: 1324-9.

21. Childers CP, Maggard-Gibbons M. Understanding costs of care in the operating room. JAMA Surg. 2018; 153: e176233.