Journal of Hand Surgery Global Online 7 (2025) 1–5

Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Original Research

Timing of Type I Open Distal Radius Fracture Fixation Does Not Affect Early Complication Rates

Eric R. Taleghani, MD, [*] James Rex, MD, [*] Samuel Gerak, BA, [†] John Velasquez, MS, [†] Kathryn Rost, BS, [†] Sonu A. Jain, MD, FACS [‡]

[*] Department of Orthopaedic Surgery, University of Cincinnati, Cincinnati, OH
[†] University of Cincinnati College of Medicine, Cincinnati, OH
[‡] Division of Plastic and Reconstructive Surgery, University of Cincinnati, Cincinnati, OH

ARTICLE INFO

Article history:
Received for publication September 9, 2024
Accepted in revised form September 20, 2024
Available online November 12, 2024

Key words:
Distal radius fracture
Gustilo Anderson
Infection
Open fracture
Trauma

Purpose: There is limited published evidence regarding the optimal management of type I open fractures of the distal radius. The purpose of this study was to compare short-term complication rates among open fractures of the distal radius, with attention to the timing of management of type I fractures. Our hypothesis was that there would not be a temporal association between treatment and infection for type I open distal radius fractures (DRFs).
Methods: A retrospective review of all open DRFs at a single level-1 trauma center over a 10-year period was performed. Patients were grouped based on Gustilo Anderson open fracture classification. The primary outcome measures were superficial and deep infection rates in all patients with a minimum of 6-month follow-up. A subgroup analysis was performed for Gustilo Anderson type I injuries with a 3-month follow-up based on time to surgery.
Results: Seventy-one patients with open DRFs were included for analysis with an average follow-up of 16.7 months. There was a higher rate of deep infection (30%) and average number of revision surgeries (3.0) in the type III cohort compared with both type II (4% and 0.6) and type I (0% and 0.39) cohorts. A subgroup analysis of 63 type I fractures with a minimum of 3-month follow-up revealed zero infections, with no difference in other complications or number of revision surgeries among patients definitively managed within 24 hours, 24–72 hours, and greater than 72 hours. Two patients were managed nonoperatively, without complication.
Conclusions: Type I open DRFs differ from higher grade DRFs with regard to demographics and injury characteristics, along with infection, complication, and reoperation rates. With no infections in the type I DRF cohort and no difference in complication rates based on time to debridement, our data suggest that it is safe to manage type I open DRFs similarly to closed injuries regarding surgical timing.
Type of study/level of evidence: Therapeutic III.

Fractures of the distal radius are one of the most common injuries to the upper extremity, with more than 643,000 occurring annually in the United States.[1–3] Open distal radius fractures (DRFs) are less common; current literature indicates a prevalence of approximately 6% to 13% of all DRFs.[4,5] Of these injuries, 50% to 94% are Gustilo Anderson (GA) grade I.[1,2,6,7] There are no agreed upon guidelines regarding the optimal management strategies for open DRFs.

In addition to restoration of normal bony architecture and function, management of open fractures generally requires additional intervention to reduce the risk of infection. Open DRFs are typically treated urgently with antibiotics and debridement, and recent studies have shown that open fractures of the distal radius can be safely treated with immediate open reduction and internal fixation (ORIF) at the time of initial debridement, with comparable outcomes with other forms of treatment including definitive external fixation or staged ORIF.[2,6,8] Although high-energy injury patterns with larger and contaminated soft-tissue defects lead to

Corresponding author: Sonu A. Jain, MD, Division of Plastic and Reconstructive Surgery, University of Cincinnati, 231 Albert Sabin Way, ML 0581, Cincinnati, OH 45267-0581.
E-mail address: sonu.jain@uc.edu (S.A. Jain).

https://doi.org/10.1016/j.jhsg.2024.09.004

higher rates of infection and complications, Gustilo Anderson type I injuries appear to have a similar risk profile to similar closed injuries.[1,5,9,10] However, urgent debridement remains the literature-reported standard of care for these injuries.

More recent studies have begun to address the question of whether urgent debridement and fixation is necessary in type I open DRFs.[11–13] The purpose of this study was to expand on this limited body of research by establishing key differences between types I and III open DRFs and determine whether time to surgical debridement and fixation affects early complication rates in type I open DRFs. We hypothesized that the early complication profile of type I DRFs, specifically wound-related complications, would be similar to that reported in the literature for closed injuries, regardless of the timing of surgical intervention.

Methods

A retrospective review of 166 consecutive open DRFs between January 2012 and December 2023 at a single level-1 trauma center was performed. All open DRFs were included, regardless of management. Patients who did not meet the minimum follow-up time (6 months for analysis across Gustilo Anderson types and 3 months for subgroup analysis of type I fractures) were excluded. A total of 98 patients were eligible for the analysis. This study was approved under the umbrella Institutional Review Board approval for retrospective studies at our institution (OS20007 IRB 2020-0116).

All eligible patients were managed by one of nine fellowship-trained trauma or hand and upper-extremity surgeons at a single, level-1 trauma center. Management (surgical vs nonsurgical) and surgical techniques varied based on individual surgeon preference, fracture pattern, and wound characteristics. In this patient cohort, all but two patients were treated surgically.

Electronic medical records were reviewed to identify patient demographic factors and medical comorbidities, including age, biologic sex, body mass index (BMI), presence of diabetes, and tobacco use. Injury characteristics, such as the mechanism of injury, Gustilo Anderson classification, location of wound, contamination, and concomitant injuries, were documented. The time elapsed from presentation to the emergency department, first administration of antibiotics, and surgical debridement was also determined for each patient. Information regarding surgical plans and techniques was obtained from the surgical notes. Information regarding postoperative complications was gathered from follow-up clinic notes.

Patients were divided into cohorts based on Gustilo Anderson classification (types I, II, or III). Demographics, injury characteristics, management strategy, and complication rates were compared between the cohorts. Patients with Gustilo Anderson type I injuries were further subclassified based on the time to surgical debridement: early (<24 h), intermediate (24–72 h), and delayed (>72 h) debridement. A similar comparison was performed between each cohort, and the primary outcome of interest was infection rate (superficial or deep) based on the time to surgical debridement. Other complications included nonunion, symptomatic hardware, hardware failure, tendon rupture, and stiffness. Superficial infection was defined as localized, superficial erythema around the surgical site, which either required oral antibiotics or was not intervened upon. Deep infections were any infection that required IV antibiotics or surgical irrigation and debridement.

Statistical analyses were carried out using IBM SPSS Statistics 29.0.2.0 (International Business Machines Corporation). Descriptive statistics, including means and SD, were calculated for continuous variables. Independent *t* tests were used to identify any statistically significant differences among normally distributed demographic factors (mean age and mean BMI). Chi-square test was used to assess significant differences among categorical variables. Fisher exact test was used when the frequencies of categorical variables were less than five.

Table 1
Demographic Data for Each Gustilo Anderson Group

Demographics	Gustilo I	Gustilo II	Gustilo III	*P* Value
N	36	25	10	
Age	55.7 ± 14.4	50.5 ± 16.3	45.7 ± 13.4	.131
Sex				.019*
M	11 (30.6%)	10 (40%)	8 (80%)	
F	25 (69.4%)	15 (60%)	2 (20%)	
BMI	29.2 ± 6.8	29.3 ± 7.1	29.4 ± 6.8	.996
Comorbidities				
Diabetes	5 (13.9%)	3 (12%)	0 (0%)	.465
PVD	1 (2.8%)	1 (4.0%)	0 (0%)	.811
CAD	3 (8.3%)	1 (4%)	0 (0%)	.544
Smoking (current)	8 (22.2%)	11 (44%)	3 (30%)	.194
Alcohol (current)	7 (19.4%)	5 (20%)	4 (40%)	.361
IVDA	2 (5.6%)	5 (20%)	0 (0%)	.094
ASA	2.44 ± 0.77	2.56 ± 0.82	2.2 ± 0.79	.481

ASA, American Society of Anesthesiologists Score; CAD, coronary artery disease; IVDA, intravenous drug abuse; PVD, peripheral vascular disease.
* Statistical significant (*P* value < .05).

Table 2
Injury Details for Each Gustilo Anderson Cohort†

Injury Details	Gustilo I	Gustilo II	Gustilo III	*P* Value
N	36	25	10	
Mechanism				.06
High energy	22 (61.1%)	16 (64%)	10 (100%)	
Low energy	14 (38.8%)	9 (39.1%)	0 (0%)	
Location of wound				.239
Ulnar	18 (50%)	14 (56%)	3 (30%)	
Radial	5 (13.9%)	4 (16%)	3 (30%)	
Volar	11 (30.6%)	6 (24%)	1 (10%)	
Dorsal	1 (2.8%)	1 (4%)	2 (20%)	
Contaminated	1 (2.8%)	8 (32%)	5 (50%)	< .001*
Nerve injury	0 (0%)	1 (4%)	3 (30%)	.001*
Acute CTS	2 (5.6%)	4 (16%)	1 (10%)	.404
Compartment syndrome	0 (0%)	0 (0%)	2 (20%)	.002*
Ipsilateral upper Extremity injury	4 (11.1%)	8 (32%)	5 (50%)	.021*

* Statistical significance (*P* value < .05).

Results

A total of 71 patients were identified who sustained an open DRF and had a minimum of 6 months of follow-up. The average follow-up time for the entire study population was 16.7 months. There were 36 patients with Gustilo Anderson type I injuries, 25 type II, and 10 type III.

Compared with the type I cohort, the type III cohort had a significantly greater proportion of men ($P = .009$). Otherwise, there were no other significant differences between the groups with respect to age, BMI, and medical comorbidities as seen in Table 1. The average patient age decreased with increasing Gustilo classification; however, this was not statistically significant. With respect to injury details (Table 2), all patients within the type III cohort sustained high-energy injuries, compared with ~60% in the types I and II cohorts. Types II and III injuries had significantly higher contamination rates, 32% and 50%, respectively, compared with 2.8% of type III injuries ($P < .001$). Type III injuries were significantly more likely to present with concomitant nerve injury, ipsilateral upper-extremity trauma, and compartment syndrome ($P = .001$, .002, and .021).

Table 3
Treatment Details for Each Gustilo Anderson Cohort

Treatment Details	Gustilo I	Gustilo II	Gustilo III	*P* Value
N	36	25	10	
Time to antibiotics (h)	2.3 ± 3.1	1.9 ± 2.3	0.73 ± 1.5	.263
Time to surgical I&D (h)	20.3 ± 11.7	22.3 ± 18.7	11.4 ± 9.2	.127
Time to definitive fixation (h)	36.1 ± 41.9	50.7 ± 71.5	30.8 ± 54	.519
Staged fixation	5 (13.9%)	6 (24%)	2 (20%)	.597
Setting				.368
Inpatient	34 (94.4%)	25 (100%)	10 (100%)	
Outpatient	2 (5.6%)	0	0	
Type of definitive fixation				.031*
Cast	0	0	0	
K-wires	0	0	1	
External fixator	1	0	1	
Volar locked plate	26	13	3	
Dorsal locked plate	4	1	0	
Dorsal bridge plate	3	0	3	
Plate combination	2	3	2	

I&D, irrigation & debridement.
* Statistical significance (*P* value < .05).

Table 4
Complications and Revision Surgery Data for Each Gustilo Anderson Cohort

Complications	Gustilo I	Gustilo II	Gustilo III	*P* Value
N	36	25	10	
Superficial infection	0	1	0	.393
Deep infection	0	1	3	.001*
Malunion	1	1	1	.602
Nonunion	4	4	4	.097
Hardware failure	2	2	0	.651
Tendon rupture	1	0	1	.812
Symptomatic implants	7	7	2	.718
Stiffness	15	10	7	.230
Average number of revision surgeries	0.39 ± 0.61	0.6 ± 0.87	3.0 ± 1.4	< .001*
Total revision surgeries	14	15	30	
Removal of hardware	9	8	3	
Irrigation & debridement (single)	0	1	2	
Irrigation & debridement (serial)	0	0	5	
Carpal tunnel release	2	2	1	
Guyon canal release	1	0	0	
Radioscapholunate fusion	1	0	1	
Darrach procedure	0	2	0	
Revision ORIF	1	2	1	
Flexor tenolysis	0	0	2	
Tendon transfer	0	0	1	
Skin graft	0	0	3	

ORIF, open reduction and internal fixation.
* Statistical significance (*P* value < .05).

Average time to antibiotics, surgical irrigation and debridement (I&D), and definitive fixation is shown in Table 3. Six (24%) type II and 2 (20%) type III injuries were fixed in a staged manner. There were zero infections in the type I cohort, one superficial and deep infection (8% infection rate) in the type II cohort, and three deep infections (30% infection rate) in the type III cohort. The difference in deep infection occurrences among groups was statistically significant ($P = .001$). Additional complication data are shown in Table 4. There were otherwise no significant differences in complication rates between GA cohorts. Patients within the type III cohort underwent an average of three revision surgeries, which was significantly greater than both the types I and II cohorts ($P < .001$). Revision procedures included removal of hardware, irrigation and debridement, revision of fixation, carpal tunnel release, tendon transfer, and salvage procedures for post-traumatic arthritis (carpal fusion and Darrach procedure). Routine removal of dorsal bridge plates was not counted as a "revision surgery."

Table 5
Demographic Data for Each Gustilo Anderson Type I Subgroup

Demographics	Early I&D (<24 h)	Intermediate I&D (24–72 h)	Delayed I&D (>72 h)	*P* Value
N	42	17	4	
Age	55.2 ± 18.6	56.3 ± 15.2	59.1 ± 25.4	.914
Sex				.143
M	12 (28.6%)	8 (47.1%)	0 (0%)	
F	30 (71.4%)	9 (52.9%)	4 (100%)	
BMI	29.9 ± 6.8	25.7 ± 5.8	30.3 ± 5.3	.088
Comorbidities				
Diabetes	9 (21.4%)	1 (5.9%)	0 (0%)	.224
PVD	1 (2.4%)	0 (0%)	0 (0%)	.776
CAD	5 (11.9%)	1 (5.9%)	0 (0%)	.619
Smoking (current)	9 (21.4%)	5 (29.4%)	1 (25%)	.807
Alcohol (current)	6 (14.3%)	7 (41.2%)	1 (25%)	.079
IVDA	4 (9.5%)	0 (0%)	0 (0%)	.344
ASA	2.45 ± 0.77	2.59 ± 0.79	1.5 ± 0.71	.181

Table 6
Injury Details for Each Gustilo Anderson Type I Subgroup

Injury Details	Early I&D (<24 h)	Intermediate I&D (24–72 h)	Delayed I&D (>72 h)	*P* Value
N	42	17	4	
Mechanism				.749
High energy	23 (54.8%)	11 (64.7%)	2 (50%)	
Low energy	19 (45.2%)	6 (35.3%)	2 (50%)	
Location of wound				.971
Ulnar	21 (50%)	9 (52.9%)	2 (50%)	
Radial	4 (9.5%)	2 (11.8%)	0 (0%)	
Volar	14 (33.3%)	6 (35.3%)	2 (50%)	
Dorsal	2 (4.8%)	0 (0%)	0 (0%)	
Contaminated	2 (4.8%)	0 (0%)	0 (0%)	.597
Nerve injury	1 (2.4%)	0 (0%)	0 (0%)	.776
Acute CTS	3 (7.1%)	0 (0%)	0 (0%)	.455
Compartment syndrome	0 (0%)	0 (0%)	0 (0%)	.999
Ipsilateral hand injury	3 (7.1%)	3 (17.6%)	0 (0%)	.368

CTS, Carpal tunnel syndrome; I&D, irrigation & debridement.

A subgroup of 63 patients with type I open DRFs who had at least 3 months of follow-up from the time of injury was created and analyzed separately. These patients were subdivided into cohorts based on the time from presentation to surgical debridement—42 were managed early within 24 hours from injury, 17 were managed in an intermediate fashion between 24 and 72 hours, and four were managed in a delayed fashion greater than 72 hours from injury. There were no significant differences with respect to demographics, comorbidities, or injury details between early, intermediate, and delayed management cohorts (Tables 5 and 6). All patients remained inpatient until their index surgical debridement. There were zero infection or wound-related complications in any of the type I subgroup cohorts (Table 7). Two patients were managed nonoperatively, without complication.

Discussion

Type I open DRFs differ from higher grade DRFs with regard to demographics and injury characteristics, along with infection, complication, and reoperation rates. With no infections in the type I DRF cohort and no difference in complication rates based on

Table 7
Complications and Revision Surgery Data for Each Gustilo Anderson Type I Subgroup

Complications	Early I&D (<24 h)	Intermediate I&D (24–72 h)	Delayed I&D (>72 h)	*P* Value
N	42	17	4	
Superficial infection	0	0	0	
Deep infection	0	0	0	
Malunion	1	0	0	.776
Hardware failure	2	1	0	.884
Symptomatic implants	6	2	0	.708
Tendon rupture	0	1	0	.780
Stiffness	13	6	3	.210
Average number of revision surgeries	0.31 ± 0.58	0.18 ± 0.39	0 ± 0	.258
Total number of revision surgeries	13	3	0	
Removal of hardware	8	2	0	
Carpal tunnel release	2	0	0	
Guyon canal release	1	0	0	
Radioscapholunate fusion	1	0	0	
Revision ORIF	1	1	0	

I&D, irrigation & debridement; ORIF, open reduction and internal fixation.

time to debridement, this suggests that it is safe to manage type I open DRFs in a similar manner to closed injuries with regard to surgical timing. We would recommend that the wound be cleaned, and antibiotics be administered at the time of presentation in the emergency department, with further management pursued on an outpatient basis. This treatment approach would have potential medical and financial benefits for patients and health care systems.

Compared with the type III cohort, patients with type I injuries were older, significantly more likely to be women with lower energy injury mechanisms, and significantly less likely to have contaminated wounds, ipsilateral upper extremity injury, or concomitant nerve injury. Type III injuries were also significantly more likely to develop deep wound infections (30% vs 0%), which required treatment with intravenously antibiotics and return to operating room for debridement. Nine of the 10 patients in the type III cohort had to return to the operating room at least one time. These results are consistent with the findings of Rozental et al[1] that wound severity was significantly associated with an increased number of postoperative complications and a higher number of surgical procedures. Glueck et al[7] has previously found that contamination of the wounds was the single most important predictor of infection. With a type III cohort of only 10 patients, we did not have a sample size large enough to run predictive multivariate analyses. Among this cohort, it appeared that the degree of wound contamination was the strongest predictor of complications.

The primary purpose of this study was to determine if time to surgical debridement affects early infection and wound-related complications in type I open DRFs. A survey of practicing surgeons carried out in 2024 by Galos et al[14] found that >60% of practicing hand surgeons would consider closed reduction alone for type 1 open DRFs. However, urgent debridement remains the literature-reported standard of care for these injuries. Studies with small cohorts of patients have reported that type I injuries were more similar to their closed counterparts.[1,5,9,10] Until recently, there were no studies that assessed whether time to debridement affects infection rates in type I open DRFs.

In 2020, Henry et al[11] identified 24 patients with type I open DRFs. There were zero infections within the cohort, and no difference in total complications or reoperations between the 17 patients treated urgently within 24 hours, and seven patients treated in a delayed manner >24 hours from injury. In 2022, Colello et al[12] compared 38 patients with type I DRFs who underwent surgery within 24 hours from injury with 24 patients who underwent surgery >24 hours from injury. They found only one deep infection in the early treatment cohort, with no difference between groups with regard to other complications, reoperations, or readmissions. Both studies concluded that type I open DRFs could be safely treated surgically >24 hours after surgery.[11,12] In our type I open DRF cohort, 42 patients underwent surgical debridement within 24 hours from arrival, 17 between 24 and 72 hours, and four were managed greater than 72 hours from presentation. All patients received antibiotics and local wound care in the emergency department. Consistent with prior studies, there were no infections in our type I DRF cohort, regardless of time to debridement. There were two patients in our cohort who were managed nonoperatively, both of whom went on to fracture union without complication. Our findings support previous studies that type I DRF has a similar risk profile to their closed counterparts, and urgent operative intervention does not impart benefit.

These findings have several implications for the patient who sustains a type I open DRF. A shift from urgent inpatient intervention to elective outpatient intervention would potentially decrease the financial burden on the patient and health care system. Even if patients are evaluated in an in-network emergency department, out-of-network or “surprise” costs associated with the clinical encounter are still common.[15] Long et al[16] studied surprise out-of-network bills specifically for upper extremity trauma patients and found that specific provider types increased odds of out-of-network billing, including hand surgeons, radiologists, and therapists. Delayed management would allow patients to seek follow-up care with in-network providers, obtain surgical care in ambulatory settings. which are known to be less expensive compared with inpatient care, and potentially avoid a surgical bill altogether.[17]

There are numerous limitations to our study. This is a retrospective study with limited sample size, likely underpowered to detect significance among low complication rates. It is also possible that there were type I open fractures that were not coded as such because of small wounds that were deemed to be insignificant by the treating surgeon and were therefore not captured in our analysis. Patients in this study were managed by one of nine different surgeons, either fellowship-trained in hand or trauma surgery. All treatment decisions were at the discretion of the treating surgeon, which introduces variability between patients, which is unable to be accounted for in the analysis, albeit increasing the external validity of the study. Our study does not capture long-term follow-up, with minimum follow-up times of only 6 and 3 months for each analysis, respectively. We selected 3 months as the minimum follow-up time for type I subgroup analysis since the primary outcome measure was infection, which tends to be an early complication. Further prospective studies with larger sample sizes and long-term follow-up would validate these results and allow for definitive treatment recommendations to be made.

Conflicts of Interest

No benefits in any form have been received or will be received related directly to this article. There were no grants or other sources of funding for this research.

References

1. Rozental TD, Beredjiklian PK, Steinberg DR, Bozentka DJ. Open fractures of the distal radius. *J Hand Surg Am*. 2002;27(1):77–85.

2. Harper CM, Dowlatshahi AS, Rozental TD. Evaluating outcomes following open fractures of the distal radius. *J Hand Surg Am*. 2020;45(1):41–47.
3. Chung KC, Spilson SV. The frequency and epidemiology of hand and forearm fractures in the United States. *J Hand Surg Am*. 2001;26(5):908–915.
4. Shahid MK, Robati S. The epidemiology and outcome of open distal radial fractures. *J Orthop*. 2013;10(2):49–53.
5. Jawa A. Open fractures of the distal radius. *J Hand Surg*. 2010;35(8):1348–1350.
6. Kurylo JC, Axelrad TW, Tornetta P, Jawa A. Open fractures of the distal radius: the effects of delayed debridement and immediate internal fixation on infection rates and the need for secondary procedures. *J Hand Surg Am*. 2011;36(7):1131–1134.
7. Glueck DA, Charoglu CP, Lawton JN. Factors associated with infection following open distal radius fractures. *Hand (N Y)*. 2009;4(3):330–334.
8. Kaufman AM, Pensy RA, O'Toole RV, Eglseder WA. Safety of immediate open reduction and internal fixation of geriatric open fractures of the distal radius. *Injury*. 2014;45(3):534–539.
9. MacKay BJ, Montero N, Paksima N, Egol KA. Outcomes following operative treatment of open fractures of the distal radius: a case control study. *Iowa Orthop J*. 2013;33:12–18.
10. Kim JK, Park SD. Outcomes after volar plate fixation of low-grade open and closed distal radius fractures are similar. *Clin Orthop Relat Res*. 2013;471(6):2030–2035.
11. Henry TW, Matzon JL, McEntee RM, Lutsky KF. Outcomes of type I open distal radius fractures: a comparison of delayed and urgent open reduction internal fixation. *Hand (N Y)*. 2022;17(5):952–956.
12. Colello MJ, Long E, Zimmerman P, Tanner SL, Faucher G. Infection rate in type I open distal radius fractures surgically treated >24 hours post-injury: a comparison study. *Hand (N Y)*. 2024;19(4):614–621.
13. Morrison KA, Rocks MC, Comunale V, et al. Association of timing with postoperative complications in the management of open distal radius fractures. *Hand (N Y)*. 2024:15589447241257644.
14. Megas A, Healy C, Frane N, Tarazi JM, Nellans K, Galos D. Management of grade 1 open distal radius fractures: a survey of practicing surgeons. *Cureus*. 2024;16(2).
15. Sun EC, Mello MM, Moshfegh J, Baker LC. Assessment of out-of-network billing for privately insured patients receiving care in in-network hospitals. *JAMA Intern Med*. 2019;179(11):1543–1550.
16. Long C, Zhang G, Sanghavi KK, Qiu C, Means KR, Giladi AM. Surprise out-of-network bills for hand and upper extremity trauma patients. *J Hand Surg Am*. 2022;47(12):1230.e1–1230.e17.
17. Crawford DC, Li CS, Sprague S, Bhandari M. Clinical and cost implications of inpatient versus outpatient orthopedic surgeries: a systematic review of the published literature. *Orthop Rev (Pavia)*. 2015;7(4):6177.