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Overlapping Surgery for Ankle Fractures: Is It Safe?

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ABSTRACT

Objective: To determine whether the practice of overlapping surgery influenced patient safety following open reduction internal fixation (ORIF) for ankle fractures.

Design: Retrospective case-control

Setting: Level 1 Academic Midwest trauma center

Patients: All patients who underwent ankle fracture ORIF by a single surgeon were eligible for our study, with 478 total patients.

Intervention: Cases that were overlapping were compared against cases that were not overlapping. Cases were defined as overlapping if there was greater than 30 minutes of overlap

between procedural times. Patient complications were recorded up to a year from the index surgery.

Main Outcome Measure: Unexpected return to surgery.

Results: There were 478 ankle fracture ORIF patients, 238 with at least 3 months follow-up; 124 (52%) in the overlapping group and 114 (48%) in the non-overlapping group. There was no difference in the rate of unexpected return to surgery (p=0.76), infection (p = 0.52), readmission (p = 0.96), painful hardware (p = 0.62), malunion (p = 0.27), nonunion (p = 0.52), or arthritis (p = 0.39) between the overlapping and non-overlapping groups. There were 467 isolated ankle fractures used for time analysis. Average procedure time was 26 minutes longer for the overlapping group than the non-overlapping group ($p < 0.01$).

Conclusion: Overlapping surgery causes increased operative time for ankle ORIF, but there was no apparent increased risk to the patients for short term complications. The need for graduated resident responsibility required by ACGME guidelines need to be weighed against the decreased efficiency of operating room time.

Level of Evidence-3

Keywords: overlapping; concurrent; academic; resident; ankle; graduated responsibility

INTRODUCTION

Overlapping surgery occurs when an attending surgeon supervises two operating rooms simultaneously in which critical portions of each procedure are not occurring simultaneously. This can allow for more efficient operating room flow, cost-effectiveness of time, and resident or fellow graduated responsibility. Although a common practice in orthopaedic surgery, the literature is mixed whether the practice is safe. The media has reported instances when overlapping surgery became concurrent surgery (attending surgeon supervising 2 rooms simultaneously where the critical aspects of the procedure are occurring simultaneously, which is not allowed by Center for Medicare Service). The purpose of this study was to determine whether the practice of overlapping surgery had an effect on patient safety following open reduction internal fixation of ankle fractures at a high volume academic trauma center.

A 2015 Boston Globe Spotlight Investigative unit article offered the public a glimpse into normal practice at many major medical centers. That article focused on “concurrent surgery,” wherein “critical portions” of two separate surgeries are being performed or overseen simultaneously by a single attending surgeon.[1] The article highlighted a case in which a severe complication occurred while a single attending surgeon was supervising two separate procedures at the same time in two different operating rooms. Overlapping surgery had been assumed to be safe[2] by many until the Boston Globe article was published. This served as an impetus to address whether overlapping procedures were safe, as there had been little data to support or refute the practice.

Our institution is a high-volume trauma center where overlapping surgeries are commonly, but not always, performed for both trauma and non-trauma conditions. Our institution utilizes resident physicians in the direct care of patients, in assistance of surgery, and

by having residents perform many portions of procedures under guidance of attending physicians. Some of the orthopaedic surgeons prefer to perform overlapping surgeries in two operating rooms to increase the efficiency of cases and allow increasing graduated autonomy to the resident involved in the case.

The purpose of this study is to determine whether overlapping orthopaedic surgery in our institution affects patient outcomes for ankle fracture ORIF. We hypothesized there would be no difference in patient safety when comparing ankle fracture ORIF between those performed in an overlapping versus consecutive manner.

MATERIALS AND METHODS

Institutional review board approval at our institution was performed prior to the start of the study. A retrospective review of all cases of ankle fracture open reduction internal fixation (ORIF) by a single surgeon at our institution was performed between 2007 and 2018. The date range was used as it corresponded to the single surgeon's time at the institution. The entirety of the surgeon's time at the institution involved working with residents and no fellows. Current Procedural Terminology (CPT) codes 27766 (open treatment of medial malleolus fracture), 27769 (open treatment of posterior malleolus fracture), 27792 (open treatment of lateral malleolus fracture), 27814 (open treatment of bimalleolar ankle fracture), 27822 (open treatment of trimalleolar ankle fracture; without fixation of posterior lip), and 27823 (open treatment of trimalleolar ankle fracture; with fixation of posterior lip) were used in this review. Individual charts were then reviewed for each case to look up the date of surgery, time into the operating room, procedure start time, procedure end time, and time out of the operating room. This information was then merged with the rest of the surgeon's operating room schedule for that

same day. If the surgeon was running two operating rooms, procedure start and stop times for ankle fracture ORIF were compared to the same surgeon's procedural start and stop times within other operating rooms. If there was greater than 30 minutes of overlap between procedural times, then the cases were deemed "overlapping." If there was less than 30 minutes of overlap or no overlap at all, then the procedures were deemed "non-overlapping."

All charts were reviewed for patient demographics time of follow up, and the presence or absence of complications up to a year from the index surgery. The primary outcome measured was an unexpected return to surgery related to the index ORIF. Secondary outcomes measured were procedure time, readmission rates, painful hardware, malunion, delayed union, infection, and posttraumatic arthritis. Syndesmosis injury requiring separate fixation was also noted. For procedure time analyses, eleven cases were excluded as the cases involved operating on another segment of the body other than the injured ankle (polytrauma). For analysis of complications following surgery, those patients with less than 12 weeks of follow up, or patients with incomplete data and records were excluded. A minimum 12 weeks follow up was considered necessary for analysis of complications. CPT codes were sub divided into groups by fracture fixation complexity: (mild - lateral malleolus or medial malleolus; moderate - bimalleolar; and difficult - trimalleolar with fixation of the posterior malleolus). There were only two cases of isolated posterior malleolus fixation which were excluded from the above subgroup analysis. Cases were also analyzed by chronological year and academic year, with "early academic year" being July through December and "late academic year" being January through June.

Statistical analyses were performed using Systat 10™ (Chicaog, Ill, 2000) software. Differences between groups of continuous were analyzed with the non-parametric Mann-Whitney U test due to non-normal distributions. The Fisher's exact test (2 x 2 groups) and

Pearson chi-square (greater than 2 x 2 groups) tests were used for differences between groups of categorical variables. Significance was set at $p < 0.05$.

RESULTS

There were 478 cases of ankle fracture ORIF from the single surgeon's records; 467 patients were included in operating time analysis after exclusion due to polytrauma cases; 238 patients met inclusion criteria for analysis of complications (follow up and records available for at least 12 weeks post-op). Average follow up of included patients was 32 weeks, when patients were typically released if asymptomatic and healed. Of these 238 patients included, 124 (52%) comprised the overlapping surgery group and 114 (48%) patients the non-overlapping group. Groups were similar in terms of age ($p=0.99$) and gender ($p = 0.38$) (Table 1).

For those patients with at least 12 weeks of follow up, there was no difference in the rate of unexpected return to surgery ($p = 0.76$) or for any of the secondary outcome measures, including infection ($p = 0.52$), readmission ($p = 0.96$), painful hardware ($p = 0.62$), malunion ($p = 0.27$), nonunion ($p = 0.52$), or arthritis ($p = 0.39$) between the overlapping and non-overlapping groups (Table 2). Table 2 reflects patients may have developed single or multiple complications requiring a return trip to surgery, while other patients may have developed complications but did not undergo a second operation.

There was no difference in the rate of unexpected returns to the operating room (Table 3) by fracture complexity ($p = 0.25$), presence of syndesmosis disruption that required additional fixation ($p = 0.83$), gender ($p = 0.69$), or timing within the academic year ($p = 0.84$) (Figure 1); post-hoc power analysis showed that a total of 3745 patients would be needed to reach 80%

power for return to OR. For the secondary outcome of increased OR time using all patients, post-hoc analysis showed this study was adequately powered over 80%.

As the time variable is independent of follow up, we analyzed the procedure time for 467 cases, excluding polytrauma cases, which showed that the overlapping group took 26 minutes longer than the non-overlapping group, on average, to fix an ankle fracture ($p < 0.01$) (Table 4). For subgroup analysis based on the fracture type or CPT code, only bimalleolar ankle fractures were found to be longer by 31 minutes ($p=0.03$). On average, bimalleolar (147 minutes) and trimalleolar fractures (159 minutes without fixation of posterior lip, 209 minutes with fixation of posterior lip) required more operative time than unimalleolar fractures (73 minutes for medial malleolar fractures and 132 minutes for lateral malleolar fractures). There were only 2 isolated posterior malleolus fractures, one in each group, which were excluded from subgroup analysis but included in analysis of all cases for OR time and averaged 130 minutes.

DISCUSSION

Concurrent surgeries were defined by the American College of Surgeons (ACS) in 2016 as "concurrent or simultaneous operations that occur when the critical or key components of the procedures for which the primary attending surgeon is responsible are occurring all or in part at the same time."[3] Critical or key components of surgery are the parts of the operation that require technical expertise and surgical judgement to optimize outcome. The ACS as well as the American Academy of Orthopaedic Surgeons (AAOS) have stated that concurrent surgery is inappropriate.[4] Overlapping surgery involves staggering the start of cases in two separate operating rooms by one surgeon. However, it differs from concurrent surgery in that the key or critical portions of the procedures are not occurring at the same time in separate operating

rooms.[3] This can allow for a more efficient operating room flow, and cost effectiveness of time for the individual surgeon, by allowing more cases to be done daily. In addition, this allows trainees to gain independence, and this has been implicated with improved patient care.[5-10] Though concurrent surgery has been deemed inappropriate, there is little consensus and limited data to support or refute the use of appropriate overlapping surgery.

There are a handful of studies that have examined outcomes following overlapping orthopaedic surgical procedures. A retrospective cohort study performed by Ravi et al demonstrated that, though somewhat rare in Ontario, overlapping surgery for hip fractures or elective hip replacement does have increased risk of complications when compared to matched consecutive (Attending surgeon performs only one case at a time) procedures.[11] Contrary to these results, several other studies in multiple specialties have shown there is no increased rate of complications when overlapping surgeries are compared to consecutive procedures.[12, 13] In orthopaedic surgery specifically, Zhang et al showed overlapping surgery yielded equivalent operating room time, procedure time, and 30-day complication rates as non-overlapping surgery in all orthopaedic specialties in an ambulatory orthopaedic surgery setting.[12] Similarly, Hamilton et al recently showed that overlapping surgery in elective knee and hip replacement yields no difference in intraoperative complication rates, component revision rates, or overall complication rates when compared to elective consecutive surgeries.[14] Dy et al recently showed that there is no increased rate of complications when comparing overlapping inpatient orthopaedic surgeries to non-overlapping inpatient orthopaedic surgeries within several academic medical centers.[15]

In this study, if there was greater than 30 minutes of overlap between procedural times, then the cases were deemed "overlapping." This cutoff of 30 minutes was chosen based on precedent set from prior studies[14] and typically corresponded to dressing and splint application but less than 30 minute overlap was unlikely to represent any significant time of closure or other aspects of the procedure that might affect outcomes.

This study demonstrated there was no apparent difference in short term outcomes (average 6 month follow up when patients were typically released if asymptomatic and healed) for those patients undergoing ankle fracture ORIF other than increased OR time. Our institution routinely utilizes resident physicians for medical and surgical care, and these trainees frequently perform noncritical aspects of the procedure. It would be expected that the operative time was longer than for an Attending orthopaedic surgeon.

At our institution, residents PGY-1 through PGY-5 rotate on the trauma service, and graduated responsibility (an ACGME requirement) would be given based on year in training and the individual resident. For junior residents, even if running 2 rooms, the Attending would typically do the entire case and model for the resident vs. a senior resident might be given more freedom to start the approach and would perform closure independently. The Attending surgeon was always present for the critical aspect of the procedure, which was typically verification of reduction and fixation. No other assistants were available.

Unplanned return to surgery occurred in 18% of the non-overlapping group and 17% of the overlapping group. The most common cause for unplanned return to surgery was due to painful hardware followed by infection. Those patients with syndesmotic injuries requiring a trans-syndesmotic screw were not routinely removed. There was no apparent association between the presence of a syndesmotic injury and unplanned return to surgery.

This study is unique in that it follows one surgeon's career at an academic county hospital, who has always worked in combination with resident physicians. There were no differences in outcomes based upon the time of the year (ie the "July Effect"), or chronological year (Figure 1).[16]

This study has several limitations. First, it is underpowered. Post-hoc power analysis demonstrated that a total of 3745 patients would be needed to reach 80% power for a 20% difference in unplanned return to the operating room. Stated another way, one would have to perform surgery on thousands of patients to determine if there is truly no difference in outcomes with overlapping surgery, as no major treatment effect was found in this study. Another weakness was 240 of the 478 patients were lost to follow up. This loss to follow up is not unexpected, as nearly 80% of blunt and penetrating trauma patients at our institution fail to follow up at 1 year.[17] Given the high number of patients lost to follow up, the complication rate at medium or long term could be much higher than found in this study. Despite these limitations, our data is consistent with recent studies that show no difference in complications or patient safety between overlapping and non-overlapping cases in short term follow up.

CONCLUSION

Overlapping surgery for ankle fracture ORIF leads to increased OR time, but there was no apparent difference in short term patient safety at our institution. The need for graduated resident responsibility under appropriate mentoring conditions needs to be weighed against increased OR time with overlapping surgery.

LEGEND

FIGURE 1: Unplanned trips to OR by month

There was no difference (p=0.84) in unexpected return trips to the operating room depending on whether the fracture fixation occurred within the early academic year (July-December) or late in the academic year (January-June).

Table 1: Demographics of patients with at least 12 weeks follow up. Groups were similar in terms of age and gender.

Table 2: Analysis of outcomes in overlapping versus non-overlapping surgery. Individual patients may have developed single or multiple complications requiring return trips to surgery, while other patients may have developed complications listed but did not undergo a second operation.

Table 3: Factors examined leading to unplanned return to surgery. Mild complexity fractures - lateral malleolus, medial malleolus; moderate complexity fractures - bimalleolar, trimalleolar without fixation of posterior malleolus; difficult fracture - trimalleolar with fixation of posterior malleolus.

TABLE 4: Analysis of case time by fracture type.

Excluding polytrauma or multiple procedure cases, isolated bimalleolar ankle fracture fixation was the only type of fracture that took significantly longer during overlapping cases. Combining all types, there was a significantly increased OR time with overlapping surgery.

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TABLE 1: Demographics of patients with at least 12 weeks follow up

	Overlapping (n=124)	Non-overlapping (n=114)	Significance (p)
Average age (years)	42 ± 14	42 ± 15	0.99
Male	55	45	0.38
Female	69	69	

Groups were similar in terms of age and gender.

TABLE 2: Analysis of outcomes in overlapping versus non-overlapping surgery

Outcome measure	Overlapping (n=124)	Non-overlapping (n=114)	Significance (p)
Unexpected return to surgery	21 (17%)	21 (18%)	0.76
Infection	11 (9%)	13 (11%)	0.52
Readmission	10 (8%)	9 (8%)	0.96
Painful hardware	26 (21%)	21 (18%)	0.62
Malunion	1 (1%)	3 (3%)	0.27
Nonunion	1 (1%)	2 (3%)	0.52
Arthritis	10 (8%)	6 (5%)	0.39

Individual patients may have developed single or multiple complications requiring return trips to surgery, while other patients may have developed complications listed but did not undergo a second operation.

TABLE 3: Factors examined leading to unplanned return to surgery

Variable	Total	Unplanned trips to OR	Significance (p)
Mild complexity fracture	97	13	0.25
Moderate complexity fracture	130	28	
Difficult fracture	9	1	
Syndesmosis injury	77	13	0.83
Time within academic year	111 early, 127 late	19 early, 23 late	0.84
Gender	101 male, 137 female	19 male, 23 female	0.69

Mild complexity fractures - lateral malleolus, medial malleolus; moderate complexity fractures - bimalleolar, trimalleolar without fixation of posterior malleolus; difficult fracture - trimalleolar with fixation of posterior malleolus.

TABLE 4: Analysis of case time by fracture type

Fracture type	Average case time (min) (n = 467)	Average overlapping case time (min) (n = 241)	Average non overlapping case time (min) (n = 226)	Significance (p)
All cases	149 ± 60 (100%)	158 ± 68 (100%)	132 ± 51 (100%)	< 0.01
Medial malleolus	73 ± 26 (3.5%)	68 ± 14 (5.3%)	88 ± 55 (2%)	0.37
Posterior malleolus	130 (0.5%)	101 (0.4%)	158 (0.4%)	n/a
Lateral malleolus	132 ± 55 (36%)	139 ± 59 (38%)	123 ± 53 (33%)	0.16
Bimalleolar	162 ± 62 (30%)	178 ± 62 (28%)	147 ± 59 (33%)	0.03
Trimalleolar -posterior lip fixation	159 ±51 (26%)	164 ±56 (23%)	155 ± 47 (29%)	0.50
Trimalleolar + posterior lip fixation	209 ±45 (4.0%)	213 ± 37 (5.3%)	202 ± 55 (2.6%)	0.75

Excluding polytrauma or multiple procedure cases, isolated bimalleolar ankle fracture fixation and all cases overall took significantly longer during overlapping cases.