Reliability of the Clavien-Dindo Classification Scale for Complications Following Shoulder Arthroplasty

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INTRODUCTION:

As more patients elect to undergo total shoulder arthroplasty (TSA) and reverse TSA (rTSA) to improve shoulder pain and function, it is vital that complications of these procedures are established. While some current literature report relatively low complication rates of common post-surgical complications, others demonstrate high rates, which consequently have a considerable effect on patient recovery. The variability in complication rates across the orthopaedic literature for may be attributable to lack of standardization in the classification systems used to define and categorize complications. Recent literature promisingly supports that the Clavien-Dindo classification system, which was first employed to assess complications following general surgery procedures, can apply to orthopaedic conditions. The current research study seeks to expand upon the current literature by not only applying a modified Clavien-Dindo scale (mCDS) to classify complications following shoulder arthroplasty, but also by assessing and categorizing the risk factors related to the grade of complication after these procedures.

METHODS:

Adult patients who underwent shoulder arthroplasty between 2012 and 2024 at a single academic medical center with at least 90 days of follow-up were included. Data collection included demographic data, baseline functional and living status, length of hospital stay, smoking status, drug use, hand dominance, procedure indication, procedure type, surgery length, American Society of Anesthesiologists (ASA) score, Charlson Comorbidity Index (CCI), laterality of injury, follow-up time and surgery-related complications. An mCDS for clinical relevance to shoulder arthroplasty was used to grade complications based on degree of intervention needed (**Table 1**). All descriptions of potential complications during patient follow-up were collected and then independently assessed by two authors. Each reviewer scored the complications twice, and reviewers were blinded to their counterpart's scores during grading. Cohen's kappa statistic was used to assessed scale reliability. Baseline characteristics were analyzed among both patients who experienced complications and those who did not. Fisher's exact and Chi-squared tests were used to analyze categorical variables while student's t-tests were used to analyze continuous variables. Bivariate logistic regressions were performed to determine predictors for complication by grade. Statistical significance was set at p-value < 0.05.

RESULTS:

Complications were graded by two blinded, independent raters using the mCD scale. Intra-rater agreement was near-perfect (93%, kappa = 0.894, $p<0.001$) for Reviewer 1 and (96%, kappa = 0.936, $p<0.001$) for Reviewer 2. Comparing Reviewer 1 and Reviewer 2 grading to determine interrater reliability resulted in near-perfect reliability for the raters' first passes (93%, kappa = 0.894, $p<0.001$), and near-perfect reliability for their second passes (93%, kappa = 0.894, $p<0.001$). In total, 127 patients were included in this analysis, 64 men and 63 women. There were 103 (81.1%) rTSA, 19 (15.0%) anatomic TSA, and 5 (3.9%) hemiarthroplasties. 50 patients (39.4%) experienced at least one complication of any grade for a total of 58 cumulative complications (**Figure 1**). The most common complication severities were Grade 1 (36.2%) and Grade 2 (36.2%). There were no patient deaths.

Patients with complications had longer average length of hospitalization compared to those without complications ($p<0.001$) (**Table 2**). Bivariate logistic regression analysis identified that surgery length in the third (152–182 minutes) quartile was significantly associated with Grade 1 complications ($p=0.049$), while being in the fourth quartile of surgery length (>182 minutes) had decreased odds of Grade 1 complications ($p=0.032$). ASA score greater than or equal to 4 was significantly associated with Grade 1 ($p=0.045$) and Grade 4 ($p=0.010$) Baseline mobility was found to be a predictor of Grade 3 complications, as those who use a walker had higher odds of complications ($p=0.025$). For Grade 4, hemiarthroplasty was found to have greater odds of complications compared to rTSA ($p=0.026$).

DISCUSSION AND CONCLUSION: This is the first study to test the reliability of the Clavien-Dindo classification system for complications following total shoulder arthroplasty. These results demonstrate near-perfect intra-rater and interrater reliability. There were complications among 39% of patients, most commonly due to neuropraxia (Grade 2). Surgery length, ASA greater than 4, use of a walker, and hemi-arthroplasty were significantly associated with complications.

Table 1. Modified Clavien-Dindo Scale for Relevant Arthroplasty Complications.

Grade	Description	Example Complications
Grade 1	Any deviation from the normal postoperative expectations of pain or patient discomfort, as well as deviation from expected return of symmetric strength. Allowed therapeutic regimens include antipyretics, antiemetics, analgesic medications including opioid and non-opioid, and physical therapy	1. Escalation of pain management: additional prescription of opioid medication beyond 1 month following surgery[9,11] 2. Significant weakness of operative arm beyond six months, defined as appreciably weaker than contralateral limb or an inability to lift 30 lbs[13,17] 3. Stiffness that has not improved by six months[14,17] 4. Postoperative fever or nausea 5. Upper extremity tendonitis
Grade 2	Deviation that requires additional management beyond analgesia or physical therapy for conditions that require either close monitoring (increased frequency of follow-up appointments) or pharmacological intervention	1. Delayed bone glenoid bone healing (>6 months) 2. Glenoid component failure or loosening 3. Postoperative neuropraxia 4. Need for blood products following surgery 5. Superficial wound infections that necessitate antibiotics without operative treatment 6. Mild post-operative hypoxemia requiring only transient oxygen support up to 2–4 liters flow.
Grade 3a	Complications that necessitate non-surgical procedural interventions and minor [33] vascular complications	1. Local injections for pain 2. Joint aspirations due to hematoma or effusion 3. Nerve blocks to control pain 4. DVT requiring anticoagulation 5. Dislocation requiring reduction
Grade 3b	Requires treatment with surgical intervention	1. Revision or reoperation on the shoulder 2. Manipulation under anesthesia 3. Incision and debridement 4. Wound washout procedures for deep infections
Grade 4	Requires specialty consult for potentially life-threatening medical problems or includes permanent nerve injury or severe vascular injury	1. Persistent upper extremity neuropathy not resolving by final follow-up 2. Pulmonary embolus 3. Postoperative hypoxemia requiring critical care intervention or long-term oxygen supplementation 4. ICU admission following surgery
Grade 5	Death of the patient	

Abbreviations: DVT = deep vein thrombosis, ICU = intensive care unit

Table 2. Baseline Demographic Characteristics of Patients with and without Complications after Shoulder Arthroplasty.

Baseline Characteristic	Without complication (n=77)	%	Any complication (n=50)	%	p-value
Mean Surgery time (SD)	149.92 (52.30)		157.14 (47.14)		0.4314
Mean Age (SD)	67.79 (9.02)		67.98 (10.45)		0.9145
Mean follow-up time, days (SD)	724.50 (552.21)		744.50 (632.88)		0.851
Mean LOS (SD)	1.29 (0.70)		1.98 (1.30)		**<0.001**
Sex					0.664
Male, n=64 (50.4%)	40	63%	24	38%	
Female, n=63 (49.6%)	37	59%	26	41%	
Race					0.738
White, n=110 (86.6%)	65	59%	45	41%	
Black, n=9 (7.1%)	6	67%	3	33%	
Asian, n=2 (1.6%)	1	50%	1	50%	
Hispanic, n=4 (3.1%)	3	75%	1	25%	
Other or unknown, n=2 (1.6%)	2	100%	0	0%	
Smoking Status					0.648
Nonsmoker, n=64 (50.4%)	41	64%	23	36%	
Current Smoker, n=19 (15.0%)	10	53%	9	47%	
Former Smoker, n=44 (34.6%)	26	59%	18	41%	
Drug use					0.959
Never, n=102 (82.3%)	61	60%	41	40%	
Current, n=13 (10.5%)	8	6%	5	4%	
Former, n=9 (7.3%)	5	56%	4	44%	
ASA score					0.406
1, n=3 (2.4%)	3	100%	0	0%	
2, n=37 (29.8%)	22	59%	15	41%	
3, n=84 (67.7%)	51	61%	33	39%	
4, n=3 (2.4%)	1	33%	2	67%	
Charlson Comorbidity Index					0.352
None (0–1), n=12 (9.7%)	7	58%	5	42%	
Mild (2), n=23 (18.5%)	17	74%	6	26%	
Mod (3–4), n=60 (48.4%)	37	62%	23	38%	
High (≥5), n=32 (25.8%)	16	50%	16	50%	
Laterality					0.248
Left, n=53 (42.7%)	29	55%	24	45%	
Right, n=74 (59.7%)	48	65%	26	35%	
Surgery Type					0.311
Reverse TSA, n=103 (83.1%)	61	59%	42	41%	
Anatomic TSA, n=19 (15.3%)	14	74%	5	26%	
Hemi-arthroplasty, n=5 (4.0%)	2	40%	3	60%	

Figure 1. Breakdown of complications by grade and frequency.

Grade 1 (56.2%) · Grade 2 (56.2%) · Grade 3a (5.2%) · Grade 3b (5.5%) · Grade 4 (9.0%)

Complication	Count
Minor wound issues (5.2%)	5
Prolonged opioid use (10.3%)	6
Postoperative nausea (1.7%)	1
Postoperative urinary retention (5.4%)	2
Prolonged scheduled OTC pain medication use (1.7%)	1
Stiffness (6.9%)	4
Prolonged pain (5.4%)	2
Rotator cuff tendonitis (1.7%)	1
Postoperative bronchitis (1.7%)	1
Antibiotics for urinary retention (1.7%)	1
Antihistamines for rash (1.7%)	1
Required blood products (6.9%)	4
Increased frequency of follow-up (1.7%)	1
Mild postoperative hypoxemia (5.4%)	2
Neuropraxia (7.2%)	10
Non-displaced acromial stress fracture (1.7%)	2
Local injection for pain (5.2%)	5
Revision surgery (5.4%)	2
Specialty consult for serious complication (15.8%)	8
Intensive care unit admission (5.2%)	5