

Advanced Multi-Layer, Watertight Closure in Total Joint Replacement: A Retrospective Study

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OBJECTIVE

- In total joint replacement procedures, surgeons have increasingly adopted an advanced multi-layer, watertight closure (aMLWC) using knotless barbed sutures and 2-octyl cyanoacrylate adhesive combined with a polyester mesh.
- The objective of the study was to compare the clinical and economic outcomes for aMLWC patients to those with conventional closure (CC) with sutures and skin staples.

METHODS

Population:

- Patients aged ≥18 years who had undergone total joint arthroplasty (TJA) of the hip or knee as elective, primary procedures during an inpatient admission occurring between January 2014 and March 2019 at one hospital facility in the northwestern United States.

Statistical Analysis

- aMLWC and CC cohorts were initially compared using descriptive analysis.
- Multivariable logistic regression was used to compare aMLWC to CC with regard to surgical site infections (SSI) within 30 and 90 days, hospital readmission within 30 and 90 days, discharge to home, and the occurrence of emergency department (ED) visits within 30 days of hospital discharge.
- Multivariable Cox regression was used to evaluate hospital readmission within 30 and 90 days and ED visits with 30 days.
- Multivariable linear regression was used to compare mean LOS between aMLWC and CC.
- All statistical analyses were conducted using SAS version 9.4 or later (SAS, Cary, NC). Alpha was set at 0.05 initially, and Benjamini-Hochberg correction was applied for multiple comparisons.

RESULTS

- A total of 1828 patients received at least one TJA procedure.
- Of these, 434 (23.7%) involved aMLWC and 1394 (76.3%) involved CC (**Table 1**).

Table 1: Patient and Procedure Characteristics

	CC		aMLWC		P-value	All	
	N	%	N	%		N	%
Total Distinct Patients ^a	1394	100.0	434	100.0		1828	100.0
Discharge year for 1st surgery ^a					<0.0001		
2014	397	28.5	0	0.0		397	21.7
2015	249	17.9	0	0.0		249	13.6
2016	399	28.6	0	0.0		399	21.8
2017	349	25.0	0	0.0		349	19.1
2018	0	0.0	358	82.5		358	19.6
2019	0	0.0	76	17.5		76	4.2
Gender					0.8851		
Female	722	51.8	224	51.6		946	51.8
Male	672	48.2	210	48.4		882	48.2
Age, years					0.0043		
Mean	64.2		65.7			64.55	
SD	9.6		9.4			9.6	
Median	64		66			64	
Race					<0.0001		
American Indian or Alaska Native	4	0.3	2	0.5		6	0.3
Asian	39	2.8	21	4.8		60	3.3
Black or African American	33	2.4	11	2.5		44	2.4
Native Hawaiian or Other Pacific Islander	1	0.1	5	1.2		6	0.3
White	1286	92.3	381	87.8		1667	91.2
Other Race	31	2.2	14	3.2		45	2.5
Smoking					0.0103		
Smoker	43	3.1	9	2.1		52	2.8
Body Mass Index					0.2955		
Mean	29.2		29.48			29.27	
SD	4.88		4.83			4.87	
Median	28.9		29.1			28.9	
Surgery type					<0.0001		
Total Hip Arthroplasty	650	46.6	227	52.3		877	48.0
Total Knee Arthroplasty	744	53.4	207	47.7		951	52.0
Distinct Procedures ^a	1554	100.0	553	100.0		2107	100.0
Total Hip Arthroplasty	716	46.1	286	51.7	0.0227	1002	47.6
Total Knee Arthroplasty	838	53.9	267	48.3		1105	52.4

CC, conventional closure; aMLWC, advanced multi-layer watertight closure; SD, standard deviation; N, number. Two-tailed P-value based on Chi-squared test for categorical variables and independent t-test for continuous variables; alpha=0.05.

^a Note: Some patients had more than one joint procedure.

RESULTS

- Unadjusted time-to-readmission, when occurring, was considerably longer following aMLWC (89.9 vs. 51.1 days, P<0.0001) (**Table 2**)
- A lower proportion of aMLWC patients required reoperations within 90 days (0.0% vs 2.6%, P<0.0001) (**Table 2**).

Table 2: Unadjusted Outcomes

Outcome	CC n=1554	aMLWC n=553	P-value ^a
SSI within 30 days, n(%)	5 (0.3%)	4 (0.7%)	0.2535 ^b
SSI within 90 days, n(%)	7 (0.5%)	5 (0.9%)	0.3196 ^b
Discharged to Home, n(%)	1488 (95.8%)	544 (98.4%)	0.0031 ^{a†}
Reoperation within 90 days, n(%)	40 (2.6%)	0 (0.0%)	<0.0001 ^{ab}
Readmission within 30 days, n(%)	29 (1.9%)	7 (1.3%)	0.3495 ^c
Readmission within 90 days, n(%)	38 (2.4%)	11 (2.0%)	0.6242 ^c
Time-to-readmission (days [SD])	51.1 (52.3)	89.9 (63.2)	<0.0001 ^{a§d}
ED visit within 30 days, n(%)	48 (3.1%)	14 (2.5%)	0.5607 ^b
Time to first ED visit (days [SD])	7.8 (5.3)	10.0 (7.5)	0.2102 ^d
LOS (days [SD])	1.7 (0.7)	1.1 (0.4)	<0.0001 ^{ad}
Procedure Time (minutes [SD])	87.2 (19.1)	87.0 (15.0)	0.8673 ^d
Operating Room Time (minutes [SD])	133.9 (21.2)	134.9 (17.2)	0.3281 ^d
Change in Pain Score (mean, [SD])	0.75 (2.7)	0.60 (2.5)	0.3534 ^e

CC, conventional closure; aMLWC, advanced multi-layer watertight closure; SSI, surgical site infection; SD, standard deviation; ED, emergency department; LOS, length of stay; n, number

^a Statistically significant difference, alpha=0.05.

^b Fisher’s Exact test

^c Chi-squared test

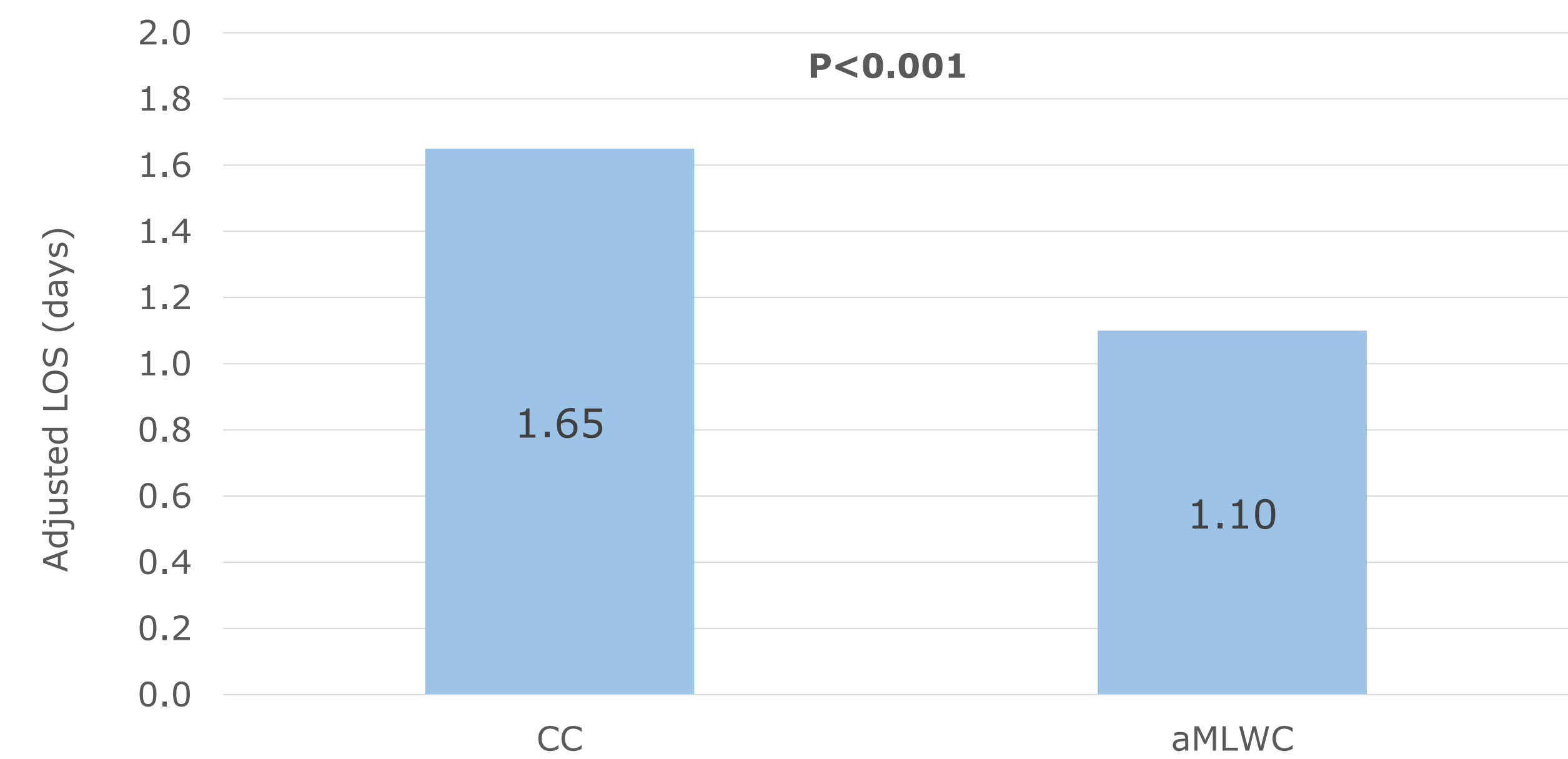
^d Independent t-test

^e Dependent t-test

Note: Discharge Status was used as a covariate in subsequent multivariable modeling where appropriate.

- Adjusted mean hospital LOS was approximately half day shorter for aMLWC patients (1.10 versus 1.65 days; P<0.001) (**Figure 1**).

Figure 1: Adjusted Mean LOS Among CC Versus aMLWC Procedures^a



CC, conventional closure; aMLWC, advanced multi-layer watertight closure; LOS, length of stay.

^a Estimated mean hospital LOS after adjusting for age, gender, BMI, Hip/Knee procedure type, and smoker status.

- aMLWC patients were more likely to be discharged to home (Odds Ratio: 4.61; P=0.002) (**Table 3**).

Table 3: Multivariable Logistic and Cox Proportional Hazard Regression Model Results

Logistic Regression Outcome	Odds Ratio (95% CI): aMLWC vs. CC	P-value
SSI within 30 days	1.75 (0.46 - 6.64)	0.413
SSI within 90 days	1.67 (0.52 - 5.36)	0.389
Readmission within 30 days	0.63 (0.27 - 1.46)	0.278
Readmission within 90 days	0.77 (0.39 - 1.53)	0.454
Discharge to Home	4.61 (1.96 - 13.60)	0.002
ED visit within 30 days	0.21 (0.03 - 1.59)	0.129
Cox Regression Outcome	Hazard Ratio (95% CI): aMLWC vs. CC	P-value
Readmission within 30 days	0.63 (0.27 - 1.45)	0.277
Readmission within 90 days	0.80 (0.40 - 1.60)	0.537
ED visit within 30 days	0.79 (0.44 - 1.45)	0.451

SSI, surgical site infection; aMLWC, advanced multi-layer watertight closure; CC, conventional closure; ED, Emergency department; CI, confidence interval

CONCLUSIONS

- Among patients undergoing total hip and knee arthroplasty in a highly optimized real-world clinical practice, aMLWC was associated with significantly shorter inpatient LOS and increased likelihood of being discharged to home as compared with conventional closure.
- These findings suggest that performing aMLWC is paramount in all total hip and total knee replacements, including high-risk optimized patients, to facilitate shorter LOS and the ability to discharge to home.