Cost-effectiveness of Surgery Versus Functional Bracing for Humeral Shaft Fractures in Adults

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INTRODUCTION:
While surgical fixation and functional treatment of humeral shaft fractures provide comparable functional outcomes, their economic impact has not yet been studied using prospective real-world data. These fractures often affect working-age adults, making cost-effectiveness an essential component of treatment selection. We evaluated the cost-effectiveness of surgery versus functional bracing using data from a pragmatic multicenter randomized controlled trial with two-year follow-up.

METHODS:
This prespecified economic evaluation was conducted alongside a multicenter, randomized clinical superiority trial, which enrolled 82 adults with closed humeral shaft fractures randomized to surgical fixation (n = 38) or functional bracing (n = 44). Baseline characteristics were balanced between groups. All patients randomized to surgery achieved union, while 14 patients (32%) in the bracing group required secondary surgery for healing complications.

Quality-adjusted life years (QALYs) were calculated using the 15D instrument. The primary outcome was the incremental net monetary benefit (INMB), defined as (incremental effects × willingness-to-pay [λ] − incremental costs), with a willingness-to-pay (WTP) threshold of €35,000/QALY ($38,150). Analyses were conducted from both healthcare and societal perspectives. The healthcare perspective included direct medical costs, while the societal perspective additionally incorporated productivity losses due to work absence.

Results were visualized using cost-effectiveness planes and cost-effectiveness acceptability curves (CEACs). The planes illustrate the distribution of bootstrapped incremental costs and QALYs, while the CEACs depict the probability that surgery is cost-effective across a range of WTP thresholds (€0 to €120,000; $0 to $130,800). Costs are reported in USD (exchange rate: €1 = $1.09), whereas all figures - the CEACs and cost-effectiveness planes - are presented in Euros.

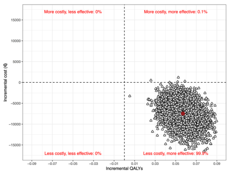
RESULTS:
From the societal perspective, surgical treatment was both more effective and cost-saving, with an INMB of $10,271 (95% CI, $4,512 to $15,924). Mean total cost per patient were $25,813 in the surgical group versus $33,123 in the bracing group. From the healthcare perspective, bracing incurred lower direct costs ($5,345 vs. $11,956) and was more cost-effective, with an INMB of −$4,454 (95% CI, −$5,684 to −$3,329). Table 1 presents a breakdown of direct costs and productivity losses.

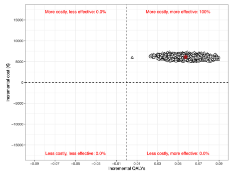
Bootstrapped cost-effectiveness planes showed 99.9% of simulations in the lower right quadrant for the societal case, indicating that surgery was both less costly and more effective (Figure 1). Conversely, when only direct costs were considered, all estimates shifted to the upper right quadrant—more effective but more costly (Figure 2). CEACs demonstrated near 100% certainty of cost-effectiveness for surgery from the societal perspective, while from the healthcare perspective, surgery surpassed a 50% probability of being cost-effective only at thresholds exceeding €105,000 ($114,500) per QALY (Figure 3 A and B).

The adjusted difference in mean 15D scores over two years was 0.029 (95% CI, 0.019–0.043), corresponding to a cumulative QALY difference of 0.071 (95% CI, 0.012 to 0.130), favoring surgery.

DISCUSSION AND CONCLUSION:
In this trial-based cost-effectiveness analysis, surgical treatment for humeral shaft fractures was more cost-effective than functional bracing from a societal perspective, largely due to reduced productivity losses. Although surgery involved higher initial costs, it led to lower total expenditures and modestly greater QALY gains over the two-year follow-up. From the healthcare payer perspective, however, functional bracing remained the more cost-effective option, owing to its lower direct medical costs.
Surgical treatment may be particularly favorable for working-age patients, as it can help reduce time away from work, whereas functional bracing offers a suitable alternative for individuals less affected by productivity loss or who prefer to avoid surgery. These results underscore the importance of shared decision-making that accounts for patient-specific

factors—such as occupational demands, risk tolerance, and personal values—especially in light of the comparable long-term clinical outcomes associated with both treatments.





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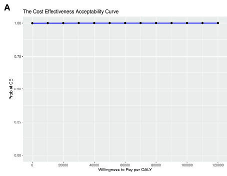

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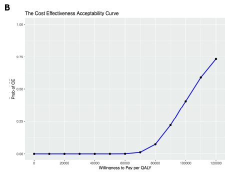

		Surgery group (n = 38)			Functional bracing group (n = 44)		
	Unit cost	Total number of units	Mean cost of unit per patient	Total cost of units	Total number of units	Mean cost of unit per patient	Total cost of units
Surgery							
Primary surgery	$4,815	38	$4,815	$182,952	2	$219	$9,629
Delayed Surgery	$3,452	0	$0	$0	12	$940	$41,324
Anesthesia general	$572	38	$572	$21,746	14	$182	$7,995
Anesthesia superior trunk block	$554	38	$554	$21,041	14	$175	$7,736
Admissions							
Community hospital bed, day	$422	11	$122	$4,640	4	$38	$1,687
Central Hospital bed, day	$766	0	$0	$0	6	$102	$4,531
University hospital bed, day	$957	157	$3,955	$150,252	66	$1,436	$63,163
Diagnostics							
X-ray	$41	228	$246	$9,370	302	$282	$12,415
ENMG	$329	10	$86	$3,282	6	$45	$1,975
Other diagnostics	$209–$213	1	$5	$213	2	$10	$419
Primary care							
Emergency department visit	$335	49	$429	$16,331	53	$401	$17,668
Primary care clinic Physician visit	$104	15	$40	$1,547	36	$84	$3,698
Primary care clinic Physician call	$57	6	$9	$338	25	$32	$1,405
Primary care clinic nurse visit	$57	12	$17	$678	8	$10	$451
Primary care clinic nurse call	$33	0	$0	$0	4	$3	$130
Occupational physician visit	$77	1	$2	$77	1	$2	$77
Follow-up							
Specialist visit	$132	178	$610	$23,202	240	$712	$31,302
Rehabilitation							
Physiotherapy, public sector	$105	152	$417	$15,844	218	$517	$22,717
Physiotherapy, private sector	$65	0	$0	$0	4	$5	$262
Occupational therapy	$95	5	$12	$474	6	$13	$569
Drug costs							
Drug costs total			$61	$2,333		$137	$6,019
Total without productivity loss			$11,956	$454,320		$5,344	$235,172
Productivity							
Work absence day	$242	2,183	$13,857	$526,586	5,141	$27,779	$1,222,256
Total			$25,813	$980,906		$33,123	$1,457,428