Randomized Controlled Trials Evaluating Tibial Osteotomy for Osteoarthritis are Fragile: A Fragility Analysis

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INTRODUCTION: Tibial osteotomy is a procedure meant to address knee malalignment and delay a total knee arthroplasty in patients with osteoarthritis. In this study we used the fragility index (FI), reverse fragility index (rFI), and fragility quotient (FQ) to determine the robustness of outcomes reported in RCTs assessing management of osteoarthritis with TO.

METHODS: PubMed, Embase, and MEDLINE were queried for RCTs (insert dates) relating to treatment of osteoarthritis with TO. We then screened for RCTs with two arms assessing surgical management of osteoarthritis with tibial osteotomy. The FI and rFI were defined as the number of outcome reversals required to alter statistical significance for significant and non-significant outcomes, respectively. The FQ was determined by dividing the FI by the sample size of each study. Subgroup analysis was performed based on the outcome category.

RESULTS: 256 articles were screened and 21 RCTs were ultimately included in our analysis. The median FI for the 158 total outcomes was 4 (IQR 3-6) with an associated median FQ of 0.083 (IQR 0.043-0.121). 20 outcomes were statistically significant with a median FI of 3 (IQR 1-8.25) and an associated median FQ of 0.083 (IQR 0.022-0.013). 138 outcomes were nonsignificant and had a median rFI of 4 (IQR 3-6) and a median rFQ of 0.083 (IQR 0.05-0.120). There were 6 studies comparing outcomes in open wedge vs closed wedge tibial osteotomies. The median FI for these studies was 5 (IQR 3-6) and the median FQ was 0.065 (IQR 0.037-0.1). Complications were the most common outcome type reported with a median FI of 4 (IQR 3-6) across 100 outcomes. The most fragile outcome category was limb length discrepancy, with a median FI of 1.5 (IQR 1-3.25). This was followed by hardware complication (median FI 2), post-op ambulatory ability (median FI 3.5), and progression of OA (median FI 4). The most stable outcome categories were clinical score/clinical improvement (median FI 8) and re-operation/intervention (median FI 9.5). DISCUSSION AND CONCLUSION:

In the current assessment of randomized controlled trials (RCTs) on tibial osteotomies (TO), it was observed that the overall median FI was 4, and the associated FQ of 0.083 (IQR 0.043-0.121). An FI of 4 indicates that reversing just 4 patient outcome events would be sufficient to alter the significance of the results. Considering the sample size, an FQ of 0.083 means that, on average, approximately 8 out of 100 patients would need to experience a different outcome to change the significance across the 158 total outcomes. Statistically significant findings had a median FI of 3 and an associated FQ of 0.053, indicating fragility in the TO literature. This low median FI and FQ demonstrate that the TO literature may be more fragile than previously recognized. Therefore, this study contributes to the increasing body of evidence supporting the inclusion of FI and FQ in RCTs that inform clinical decision-making.

Our fragility analysis of RCTs evaluating HTO efficacy for knee OA revealed fragility in reported outcomes. These findings are consistent with current studies in orthopedic literature and indicate that changing a small percentage of outcomes may alter the significance of the study. Incorporating FI, rFI, and FQ alongside traditional metrics in RCTs will provide clinicians with more comprehensive data to inform their clinical decision making.

Table 2 – Fragility data based on tri	al and outcome charact	teristics		1	Table 2 Puberous enclusis f	er intercention of		d hu multiple
					Table 5 – Subgroup analysis i	or intervention co	omparisons assesse	a by mataple :
	Number of Outcomes	FI, Median (IQR)	FQ, Median (IQR)			Number of	Number of	FI, Median
All RCT Outcomes	158	4 (3-6)	0.083 (0.043-0.121)]		studies	outcomes	(IQR)
Significant Outcomes (P<0.05)	20	3 (1-8.25)	0.053 (0.022-0.013)	1	Open Wedge vs. Closed Wedge	6	45	5 (3-6)
Nonsignificant Outcomes (P≥0.05)	138	4(3-6)	0.0833 (0.050-0.120		High Tibial Osteotomy vs.			
					Knee Joint Distraction	2	32	3 (2-7)

Table 4 – Subgroup analysis based on outcome category								
	Number of outcomes	FI, Median (IQR)	FQ, Median (IQR)					
Complications/adverse events	100	4 (3-6)	0.066 (0.043 - 0.101)					
Other	15	5 (4-6.5)	0.1 (0.082 - 0.118)					
Progression of OA	2	4 (3.5-4.5)	0.058 (0.051 - 0.065)					
Loss of Correction	6	4.5 (4-5.75)	0.099 (0.096 - 0.107)					
Hardware Complication	5	2 (1-6)	0.083 (0.014 - 0.1)					
Pain and Function	9	4 (3-5)	0.2 (0.15 - 0.25)					
Limb Length Discrepancy	4	1.5 (1-3.25)	0.025 (0.017 - 0.054)					
Postop Weight/Ambulatory Ability	10	3.5 (2.25-5)	0.062 (0.047 - 0.099)					
Reoperation/Intervention	4	9.5 (6.25-11.5)	0.149 (0.089 - 0.184)					
Clinical Score/Clinical	-	0.(7.0)	0.45 / 0.440 0.475)					