Risk of Fragility Fracture Is Decreased in Patients Who Underwent Bariatric Surgery

Daniel S. Yang[1], Alan H Daniels[2], Bryant W Oliphant, Kevin Chan
[1]Department of Orthopaedic Surgery, University of Michigan, [2]University Orthopedics, Inc.

INTRODUCTION: Bariatric surgery has been associated with weight loss, correction of obesity-related conditions, and improvements in quality of life and longevity. Two main types of bariatric surgeries exist, namely malabsorptive procedures or restrictive procedures. However, there are concerns that bariatric surgery may increase the risks of subsequent fragility fractures through metabolic changes, decreased vitamin D absorption, and decreased bone mineral density (BMD). There is also a concern that malabsorptive procedures may affect bone health more than restrictive procedures because the small intestinal absorption is partially bypassed, thus leading to malabsorption of fat-soluble vitamins, such as vitamin D. We hypothesize that a history of bariatric surgery leads to increased risk of fragility fracture.

METHODS: The PearlDiver Research Program was used to study four cohorts of patients through deidentified medical records of claims consisting of some commercial insurance, Medicare, Medicaid, and self-pay. These cohorts were patients who 1. underwent malabsorptive surgery (Roux-en-Y-Gastric Bypass, One Anastomosis Gastric Bypass, Single Anastomosis Duodeno-Ileal Bypass + Sleeve Gastrectomy, and Biliopancreatic Diversion with Duodenal Switch), 2. who underwent restrictive surgery (sleeve gastrectomy), 3. who were obese qualifying for but not undergoing bariatric surgery (BMI>40, or BMI>30 with a specific medical comorbidity), and 4. non-obese individuals. Cohorts were matched by age, sex, insurance plan type, and medical indication for bariatric surgery. Matching yielded cohorts of different numbers because 1:1 was done in a stepwise fashion and was not able to be done simultaneously across all cohorts. Risk of hip, pelvis, spine, wrist, or humerus fragility fracture, excluding for fracture due to traumatic etiologies (specified using ICD-9/10 codes), at 3 years was compared between cohorts through multivariable logistic regression, controlling for Elixhauser Comorbidity Index (ECI).

RESULTS: Between 2010 and 2022, cohorts consisted of 87849 malabsorptive surgery, 87849 restrictive surgery, 40804 obese, and 65967 non-obese patients after matching. The risk of fragility fracture in patient cohorts prior to matching, at 3 years was most for spine fracture at 0.9% in malabsorptive surgery, 0.7% in restrictive surgery, 0.7% in any bariatric surgery, 3.2% in obese, and 0.8% in nonobese patients (Table 1). After matching and controlling for ECI, obesity at a degree qualifying for bariatric surgery was associated with decreased risk of hip fragility fracture (OR=0.56, p=0.0010) but increased risk of wrist fragility fracture (OR=1.52, p<0.0001) (Table 2, 3). Patients who underwent bariatric surgery had decreased risk of fragility fracture at 3 years at the hip (OR=0.47, p<0.0001), pelvis (OR=0.36, p<0.0001), spine (OR=0.45, p<0.0001), wrist (OR=0.39, p<0.0001), and humerus (OR=0.40, p<0.0001), compared to obese patients who did not undergo surgery. However, malabsorptive compared to restrictive surgery was associated with increased risk of fragility fracture at 3 years at the hip (OR=1.79, p<0.0001), pelvis (OR=1.64, p=0.0142), spine (OR=1.20, p=0.0027), wrist (OR=1.33, p<0.0001), and humerus (OR=1.48, p<0.0001).

DISCUSSION AND CONCLUSION: For all bariatric surgery, the present study provides evidence for a protective effect of weight loss against the risk of fragility fractures. Restrictive surgery seems more protective than malabsorptive procedures because it does not bypass the small bowel, which can lead to changes in alimentary-associated hormones and risk for metabolic bone disease. Obesity itself has site-specific influence on fracture risk, for example the wrist may experience higher forces in a fall on an outstretched hand versus the hip may experience increases in BMD in increased weight-bearing load. Regardless, bariatric surgery is associated with decreased risk of fragility fracture at all sites. Orthopaedic surgeons should remain leaders of musculoskeletal care by referring their obese patients for evaluation of bariatric surgery to reduce their risk of future fragility fracture.

Table 1. Incidence of Fragility Fracture at 3 Years by Unmatched Patient Cohort

		n	Incidence (# per 10,000)
Hip	**Malabsorptive**	300	26.1
	Restrictive	227	12.1
	Bariatric Surgery	518	17.2
	Obese	4670	93.4
	Nonobese	2782	55.6
Pelvis	**Malabsorptive**	101	8.8
	Restrictive	110	5.9
	Bariatric Surgery	209	6.9
	Obese	1831	36.6
	Nonobese	926	18.5
Spine	**Malabsorptive**	982	85.4
	Restrictive	1224	65.1
	Bariatric Surgery	2186	72.6
	Obese	15825	316.5
	Nonobese	4066	81.3
Wrist	**Malabsorptive**	665	57.8
	Restrictive	774	41.2
	Bariatric Surgery	1424	47.3
	Obese	8339	166.8
	Nonobese	4110	82.2
Humerus	**Malabsorptive**	561	48.8
	Restrictive	576	30.7
	Bariatric Surgery	1129	37.5
	Obese	7846	156.9
	Nonobese	2495	49.9

Table 2. Comparisons Between Matched Cohorts for Risk of Axial Skeleton and Lower Extremity Fragility Fracture at 3 Years

	Hip			
	aOR	**95%CI**		**p-value**
Obese vs. Nonobese	0.56	0.40	0.79	**0.0010**
Bariatric Surgery vs. Obese	0.47	0.39	0.57	**<0.0001**
--Restrictive Surgery vs. Obese	0.36	0.28	0.46	**<0.0001**
--Malabsorptive Surgery vs. Obese	0.63	0.51	0.79	**<0.0001**
Malabsorptive Surgery vs. Restrictive Surgery	1.79	1.40	2.32	**<0.0001**
	Pelvis			
	aOR	**95%CI**		**p-value**
Obese vs. Nonobese	0.77	0.47	1.27	0.3180
Bariatric Surgery vs. Obese	0.36	0.27	0.49	**<0.0001**
--Restrictive Surgery vs. Obese	0.29	0.20	0.42	**<0.0001**
--Malabsorptive Surgery vs. Obese	0.48	0.34	0.68	**<0.0001**
Malabsorptive Surgery vs. Restrictive Surgery	1.64	1.10	2.44	**0.0142**
	Spine			
	aOR	**95%CI**		**p-value**
Obese vs. Nonobese	1.08	0.9	1.29	0.8210
Bariatric Surgery vs. Obese	0.45	0.41	0.49	**<0.0001**
--Restrictive Surgery vs. Obese	0.42	0.37	0.47	**<0.0001**
--Malabsorptive Surgery vs. Obese	0.50	0.45	0.56	**<0.0001**
Malabsorptive Surgery vs. Restrictive Surgery	1.20	1.06	1.34	**0.0027**

Multivariate regression adjusted for ECI.
Bold represents p<0.05 considered statistically significant

Table 3. Comparisons Between Matched Cohorts for Risk of Upper Extremity Fragility Fracture at 3 Years

	Wrist			
	aOR	**95%CI**		**p-value**
Obese vs. Nonobese	1.52	1.25	1.85	**<0.0001**
Bariatric Surgery vs. Obese	0.39	0.34	0.43	**<0.0001**
--Restrictive Surgery vs. Obese	0.33	0.29	0.38	**<0.0001**
--Malabsorptive Surgery vs. Obese	0.44	0.38	0.5	**<0.0001**
Malabsorptive Surgery vs. Restrictive Surgery	1.33	1.16	1.53	**<0.0001**
	Humerus			
	aOR	**95%CI**		**p-value**
Obese vs. Nonobese	1.24	0.99	1.56	*0.0607*
Bariatric Surgery vs. Obese	0.40	0.35	0.45	**<0.0001**
--Restrictive Surgery vs. Obese	0.32	0.27	0.38	**<0.0001**
--Malabsorptive Surgery vs. Obese	0.49	0.42	0.56	**<0.0001**
Malabsorptive Surgery vs. Restrictive Surgery	1.48	1.26	1.74	**<0.0001**

Multivariate regression adjusted for ECI.
Bold represents p<0.05 considered statistically significant