Skeletal Health after Bariatric Surgery

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- I have no personal financial relationships with any relevant pharmaceutical companies

Objectives

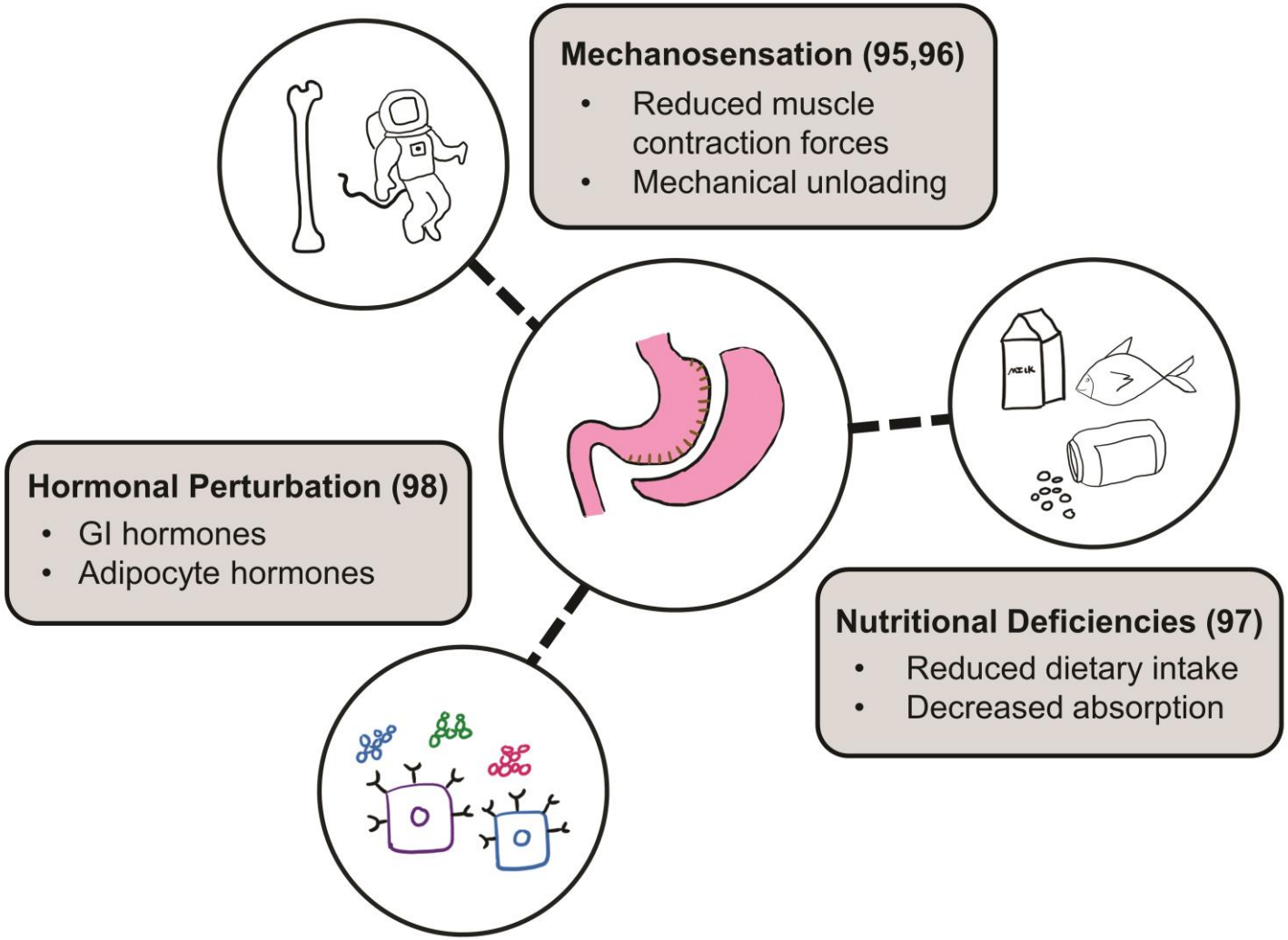
- Describe the variable impact of different bariatric procedures on bone metabolism
- Define fracture risk after bariatric surgery
- Review clinical recommendations for management of skeletal health after bariatric surgery

Case Presentation

- 47 year old postmenopausal woman with right femoral neck fracture s/p fall from standing
  - » Prior Roux-en-Y gastric bypass (RYGB) 7 years ago (lost 130 lbs)
  - » Calcium carbonate 600mg QD + Vitamin D 1000 IU QD
- Labs: normal calcium, 25OHD, PTH
- DXA: T -3.0 at PA spine, T -3.3 at femoral neck

Did her previous RYGB surgery contribute to her current osteoporosis and hip fracture?

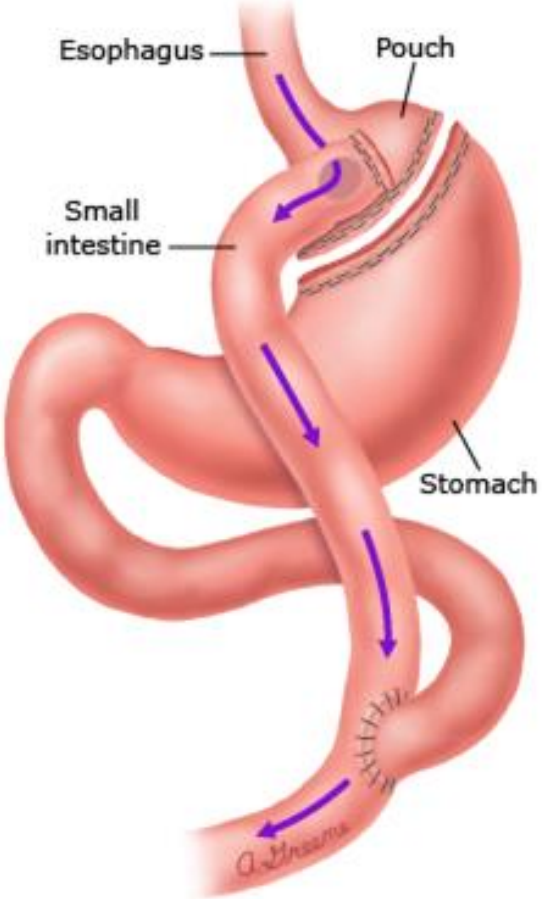
Why might bariatric surgery be bad for bone?



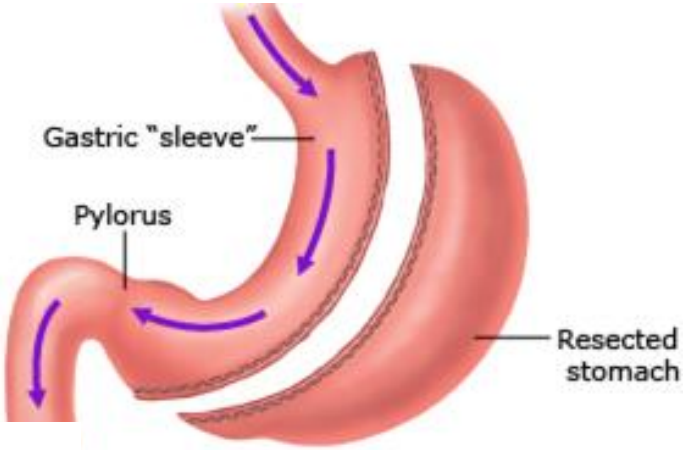
Beavers et al, Eur J Endo 2020

DIFFERENTIAL EFFECTS ON BONE

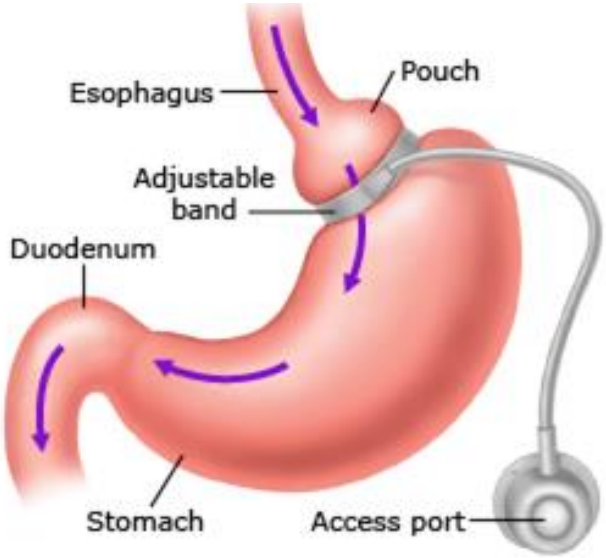
Roux-en-Y gastric bypass (RYGB)



Sleeve gastrectomy (SG)



Adjustable gastric banding (AGB)



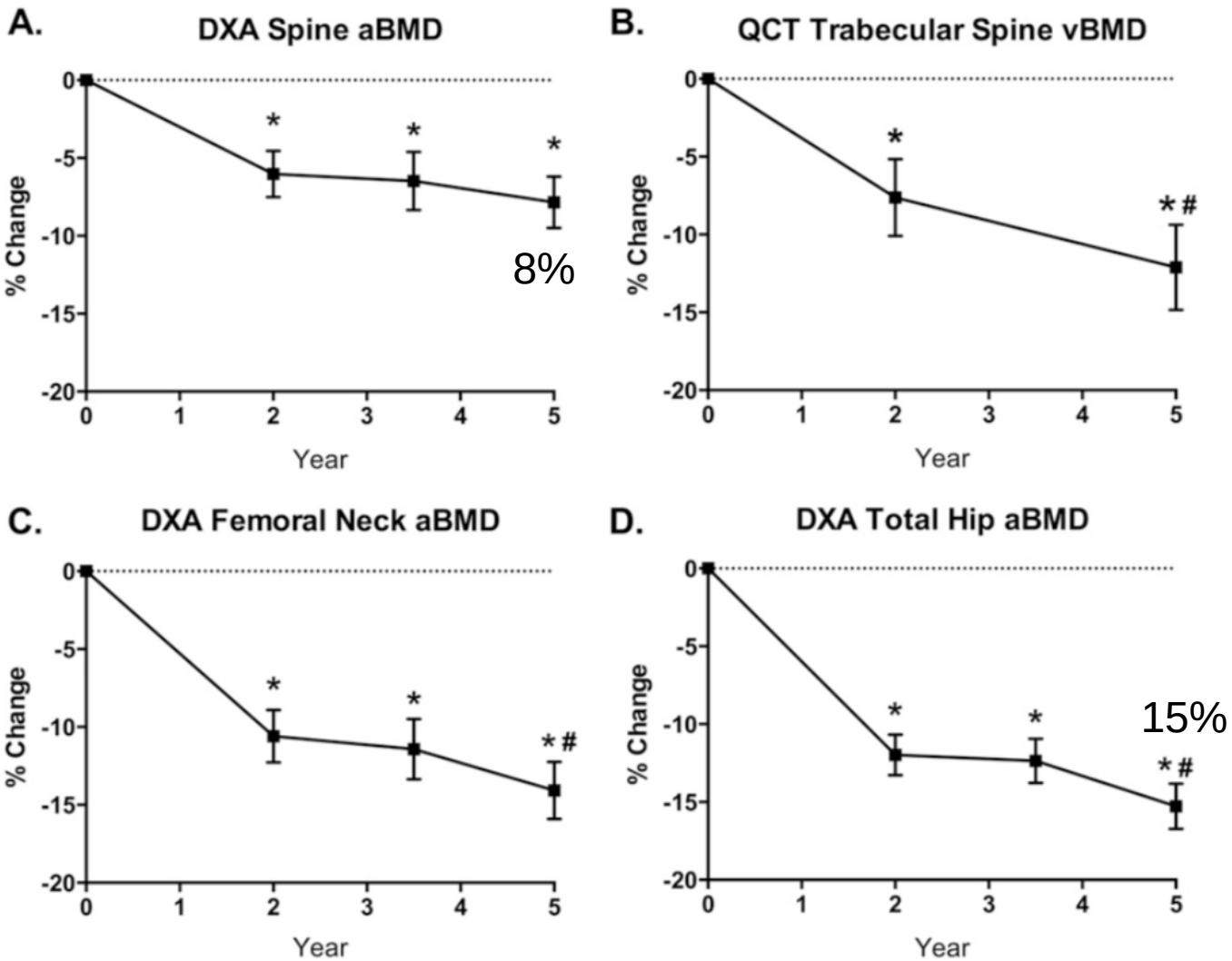
Rapid increase in utilization of bariatric surgery

<1% of eligible patients receive bariatric surgery

Angrisani et al, Obes Sug 2015; Khorgami et al Surg Obes Rel Dis 2017

BONE DENSITY AND BARIATRIC SURGERY

Bone loss in the 5 years after RYGB



Despite aggressive Ca/D supplementation and stable serum calcium, 25OHD, and PTH

Postmenopausal women may be particularly susceptible to bone loss

Schafer et al JBMR 2018

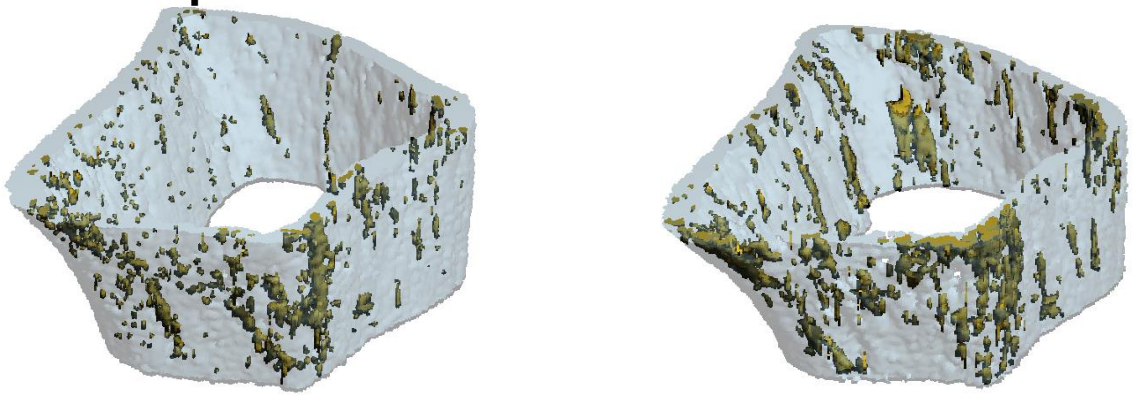
Lindeman et al JCEM 2018

Increase in cortical porosity after RYGB

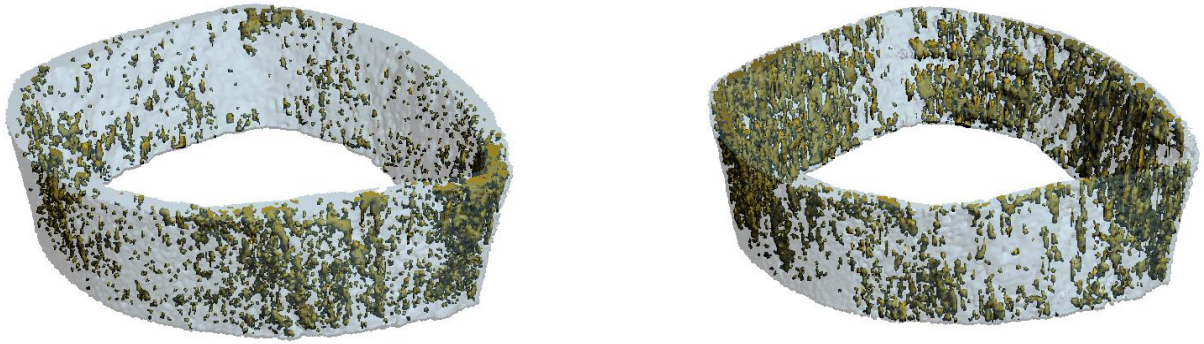
Pre-operative

5 years after RYGB

↓ Cortical vBMD
↓ Trabecular vBMD
↑ Endocortical resorption
↓ Trabecular thickness



Radius

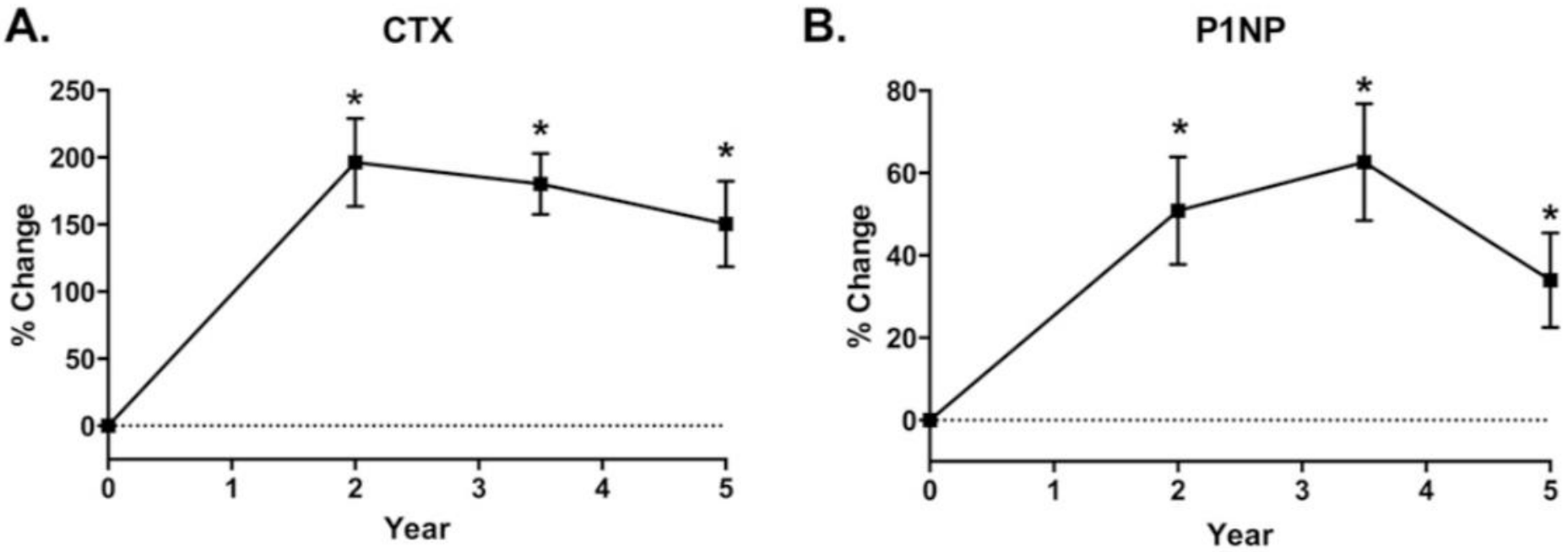


Tibia

Lindeman et al JCEM 2018

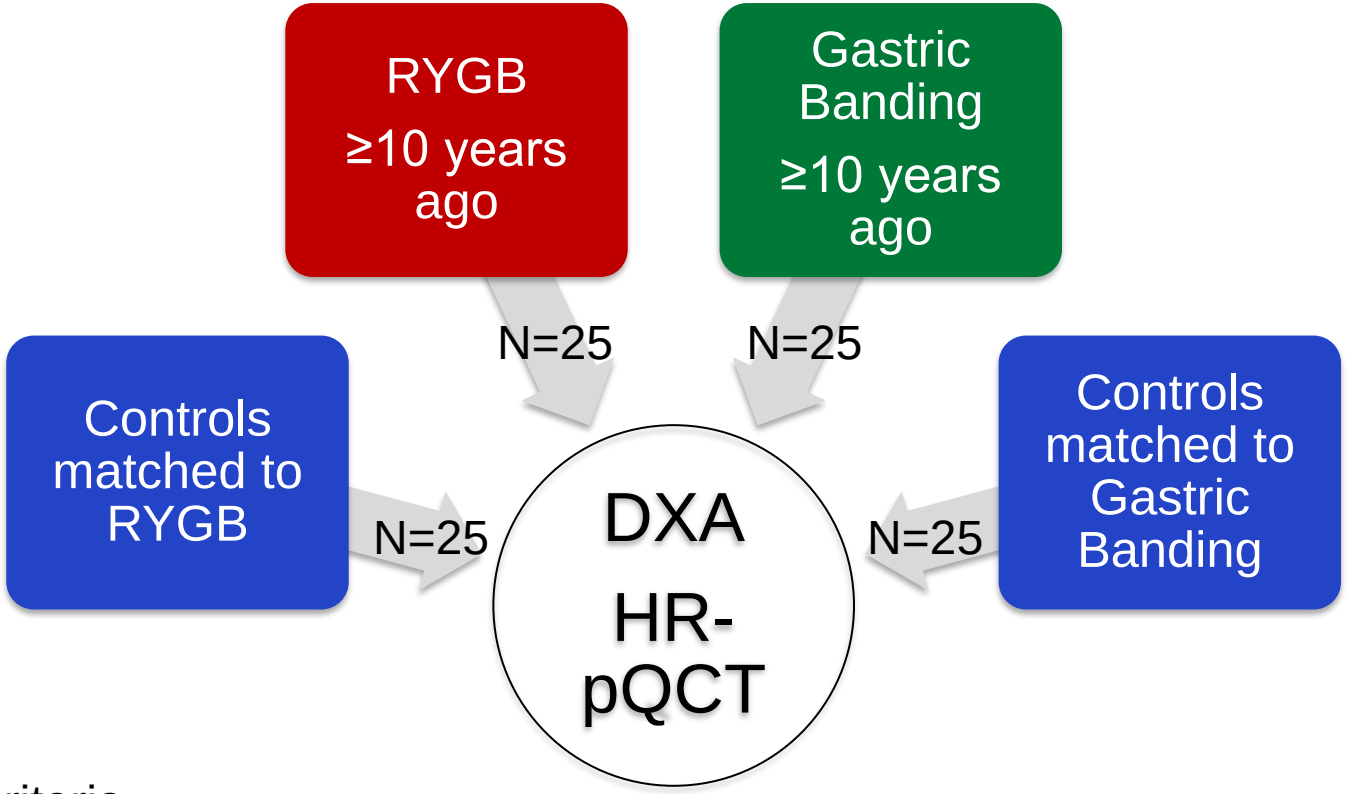
Increase in bone turnover after RYGB

Bone resorption increases within the first week of surgery, even prior to weight loss Yu et al JCEM 2016



Lindeman et al JCEM 2018

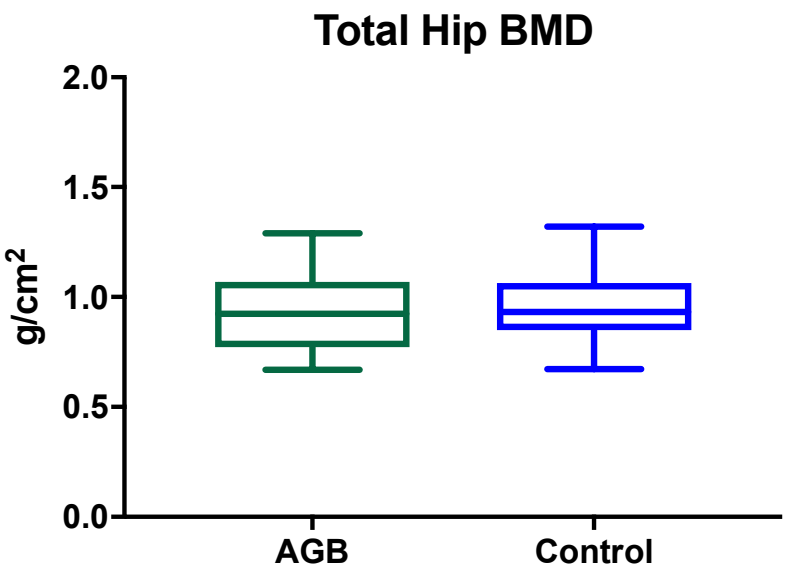
Long-term outcomes ≥ 10 years



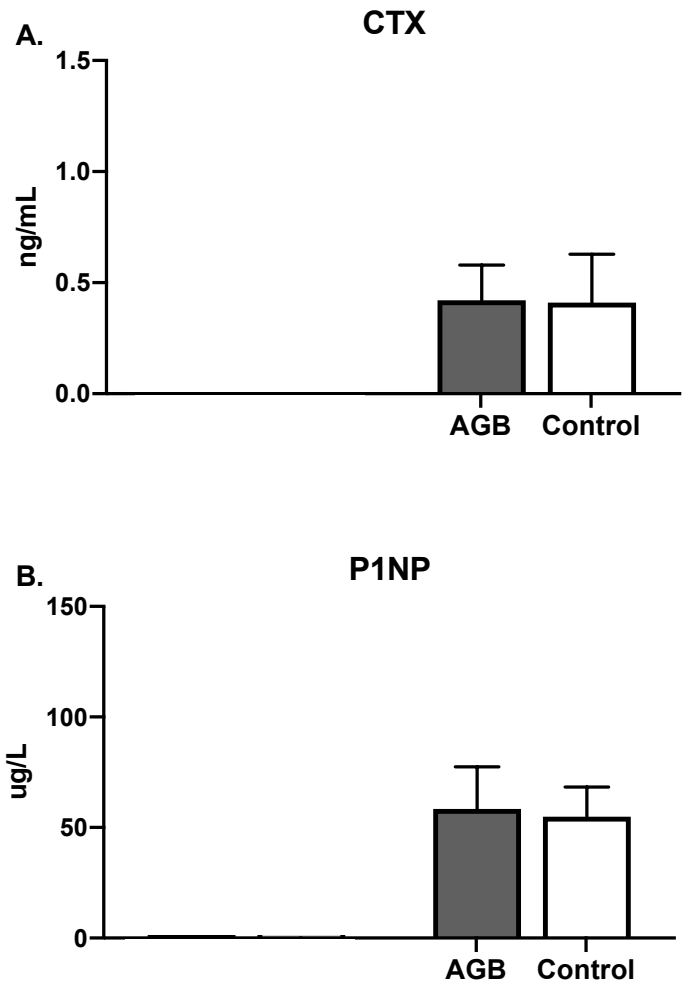
<u>Matching criteria</u>
BMI ± 4 kg/m^2
Age ± 5 years
Sex / Menopause status
Race / Ethnicity

Is amount of bone loss physiologically appropriate for the patient's new lower weight?

Adjustable Gastric Banding patients have similar hip BMD as matched controls

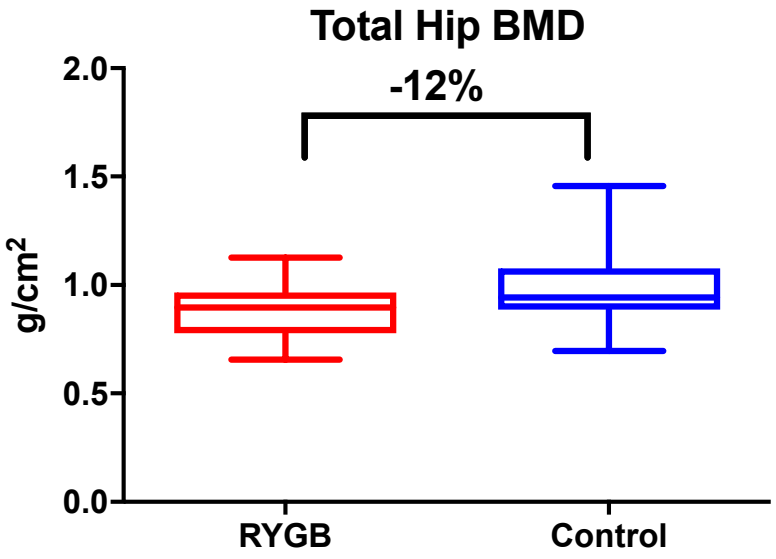


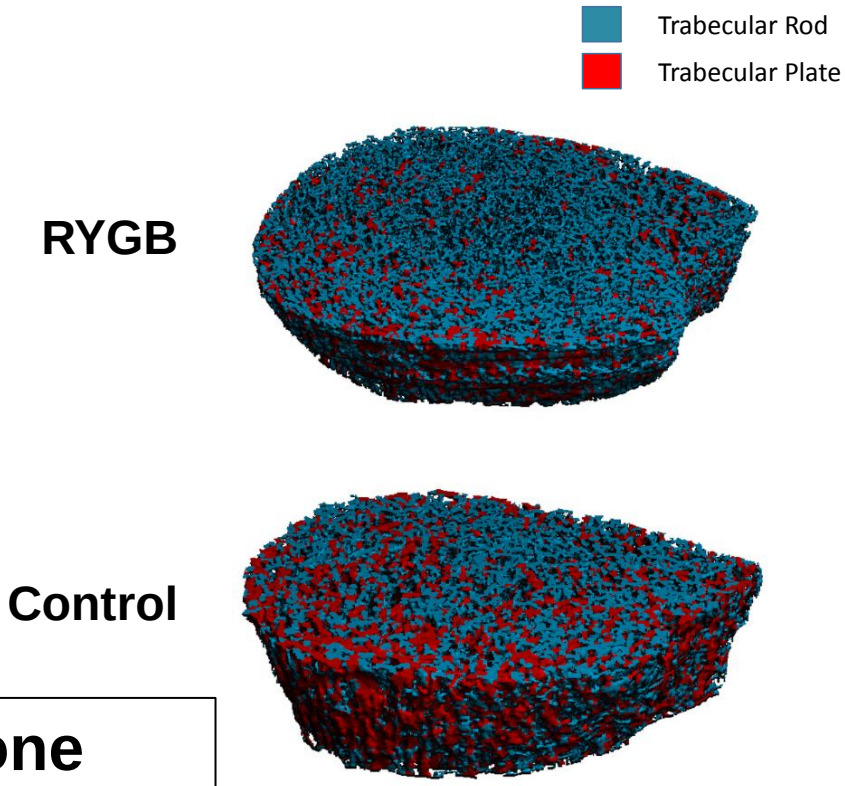
Similar BMD results at femoral neck and spine



Lindeman, Rushin et al JBMR 2020

Lower hip BMD and altered microarchitecture in RYGB patients than matched controls

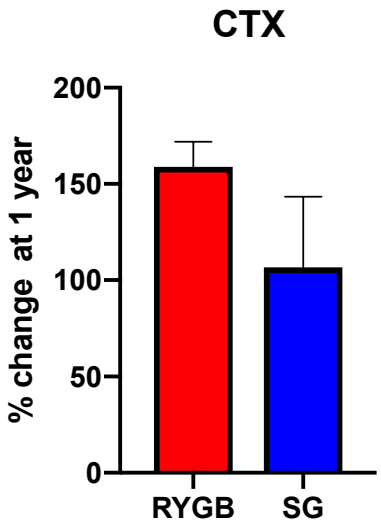


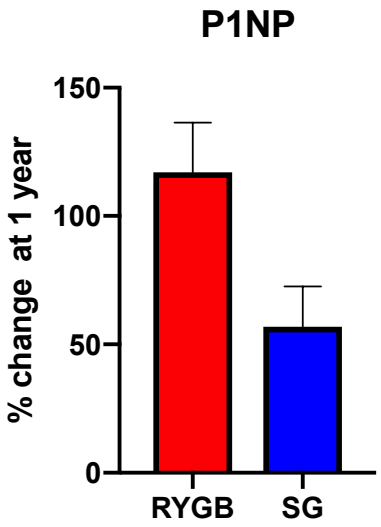


Unlike gastric banding, bone deterioration after RYGB exceeds the physiologic expectations of post-surgical weight

Lindeman, Rushin et al JBMR 2020

Sleeve gastrectomy (SG) increases bone markers, although less than RYGB

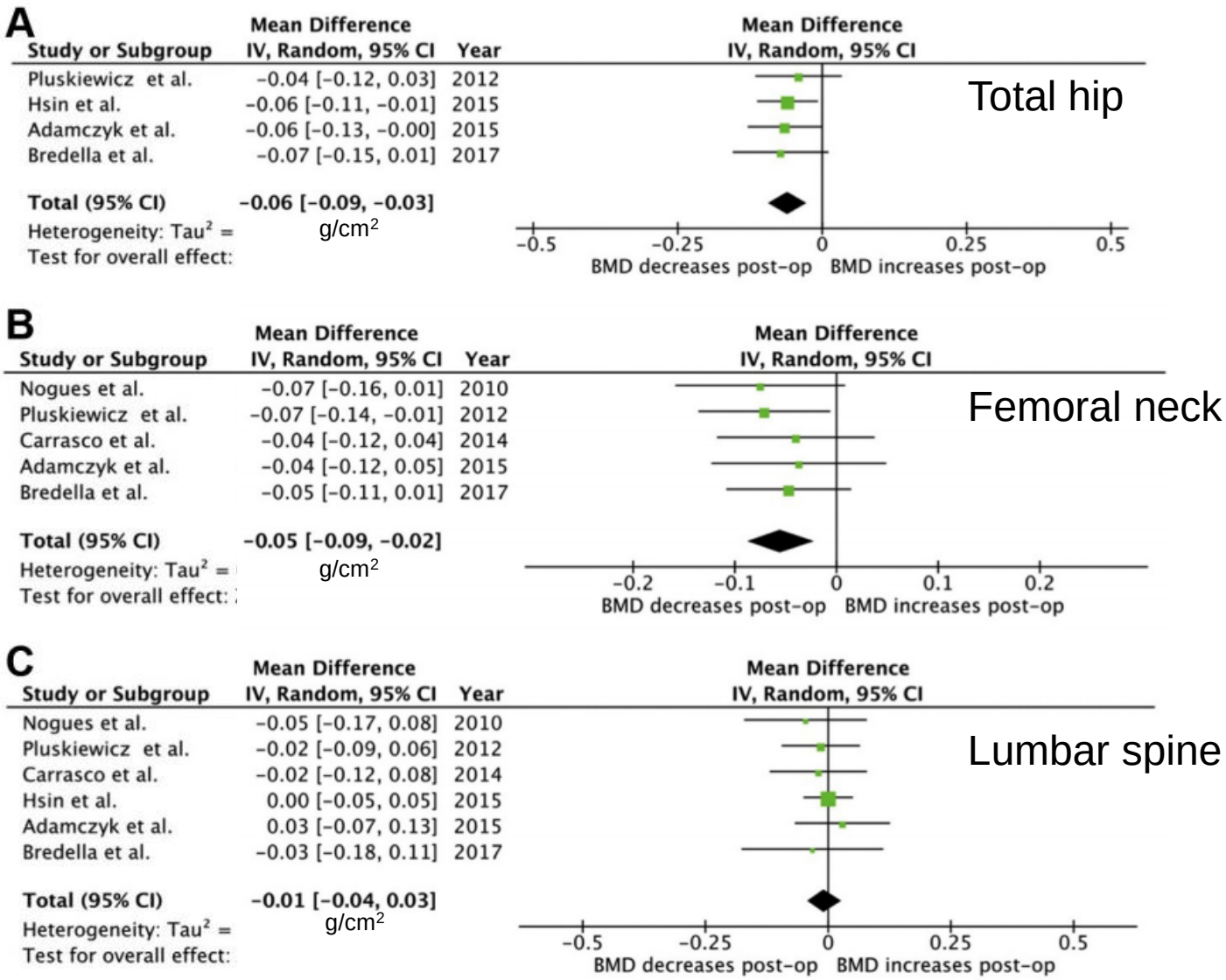




Bredella et al Bone 2017

Sleeve Gastrectomy and Bone Density

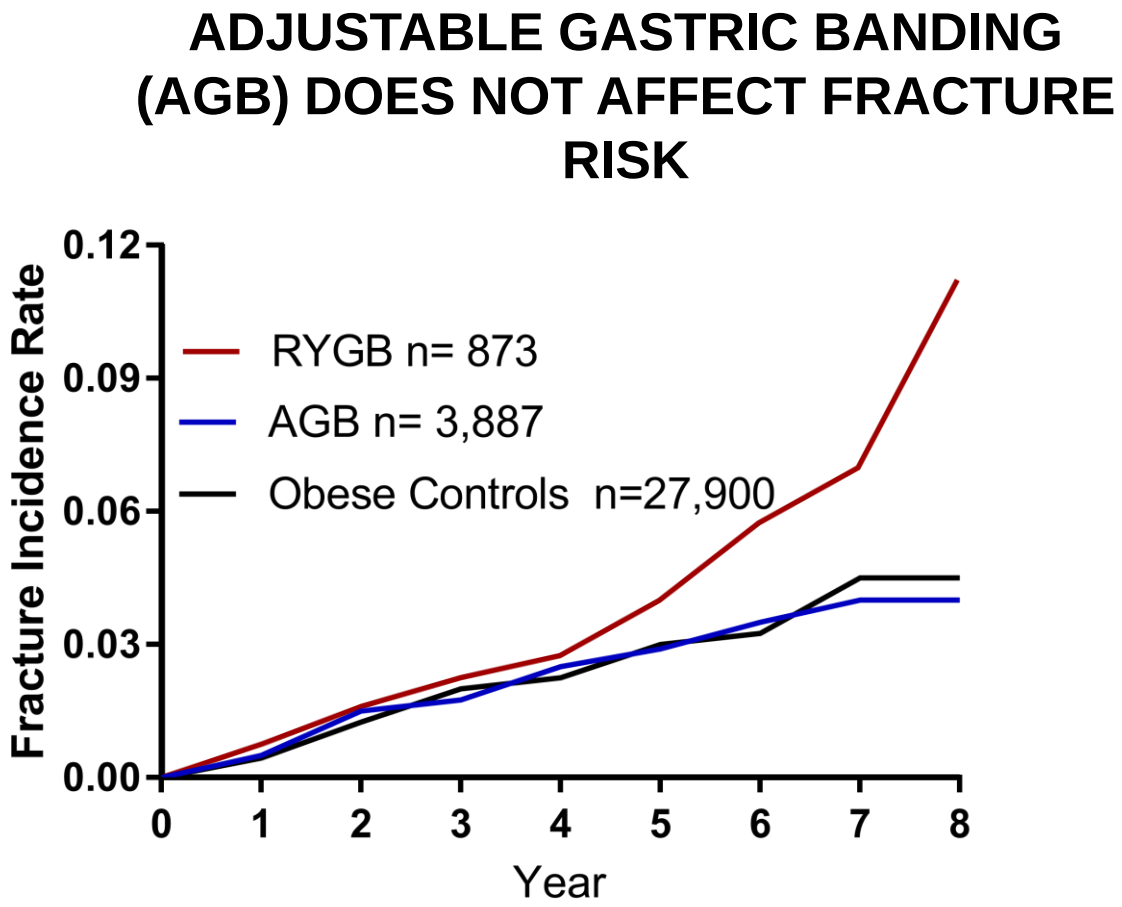
6-12 month f/u for most studies



Jaruvongvanich et al Surg Obes Rel Dis 2019

FRACTURES AND BARIATRIC SURGERY

Canada study



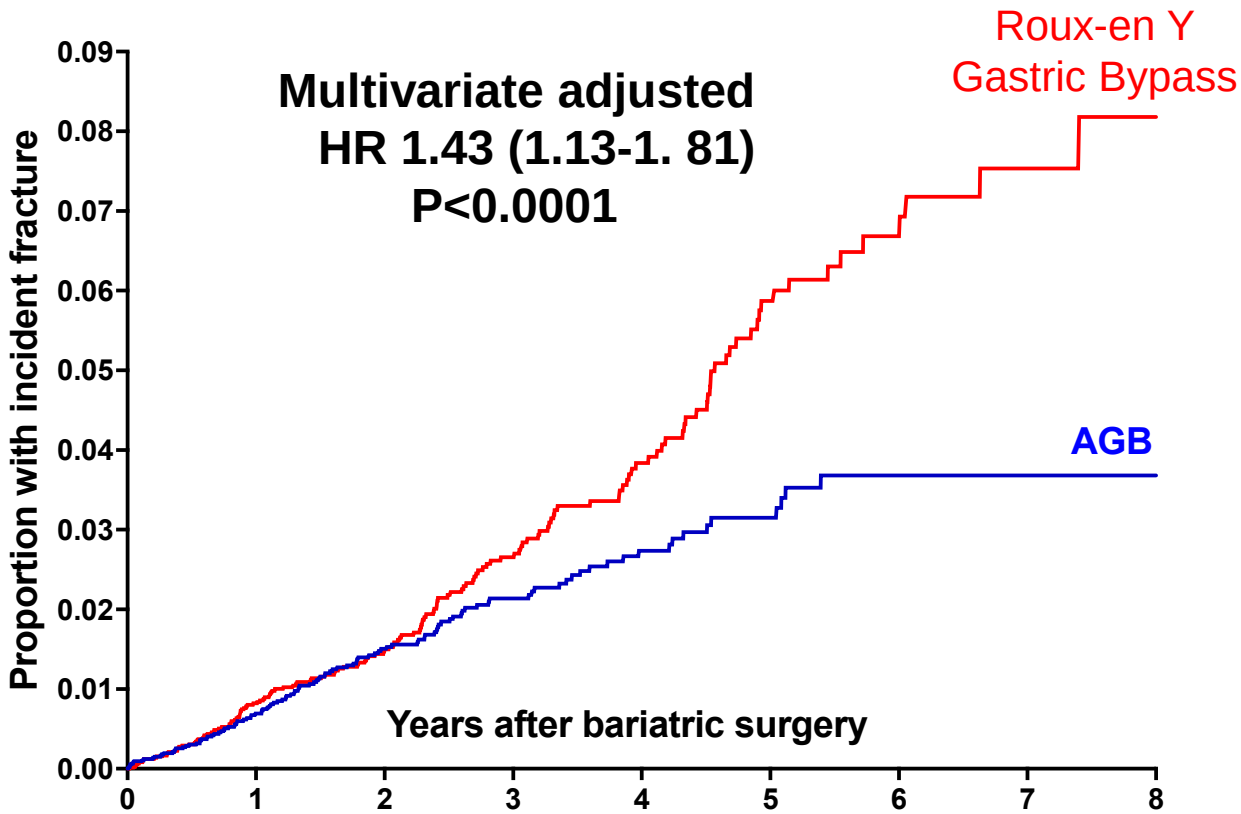
Adapted from Rousseau et al, BMJ 2016

RYGB increases non-vertebral fracture risk

Propensity-score matched cohort
N= 15,032 adults

Administrative claims database

Increase in hip, pelvis, and wrist fractures



Number at risk	RYGB	7516	6217	4229	2764	1735	1032	578	306	143
	AGB	7516	6217	4359	2937	1834	1122	621	307	73
Events	RYGB	--	50	27	35	20	22	5	3	1
	AGB	--	42	37	19	10	6	4	0	0

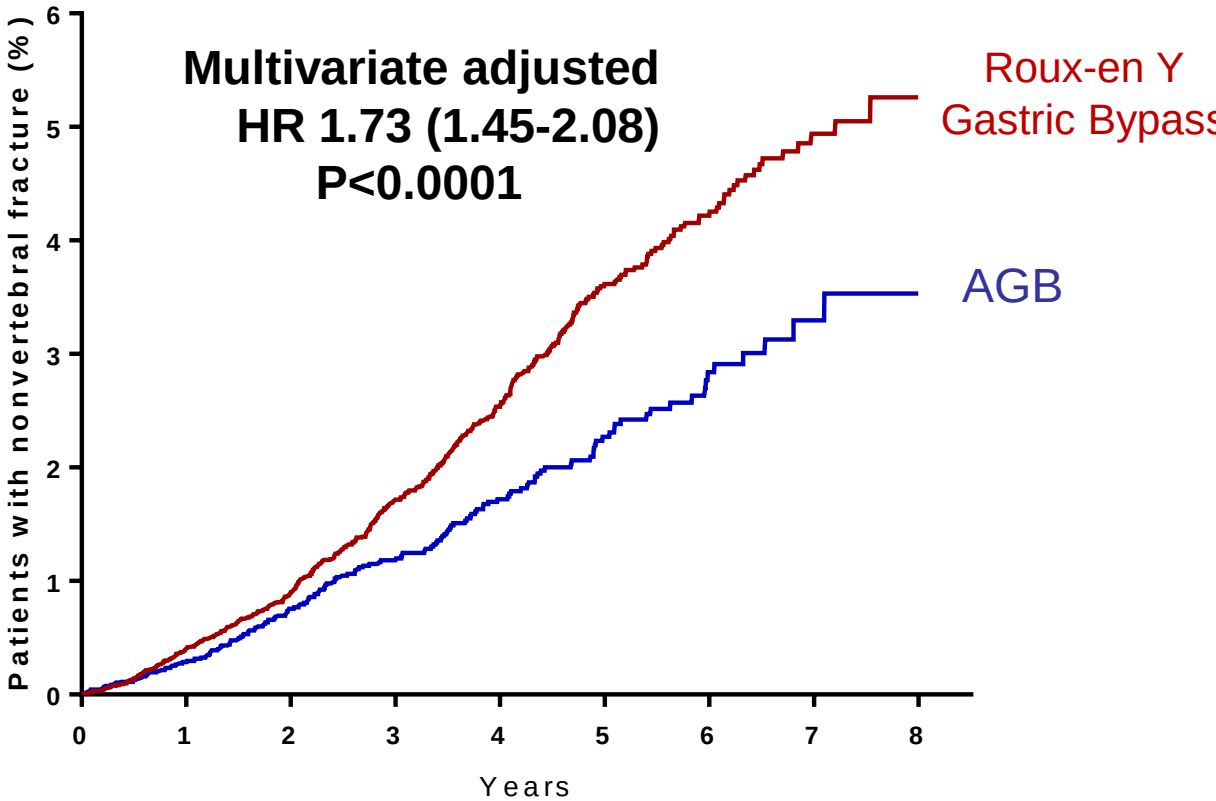
Only 6% of cohort >60y

Yu et al JBMR 2017

RYGB increases non-vertebral fracture risk

Medicare Recipients
N=42,345

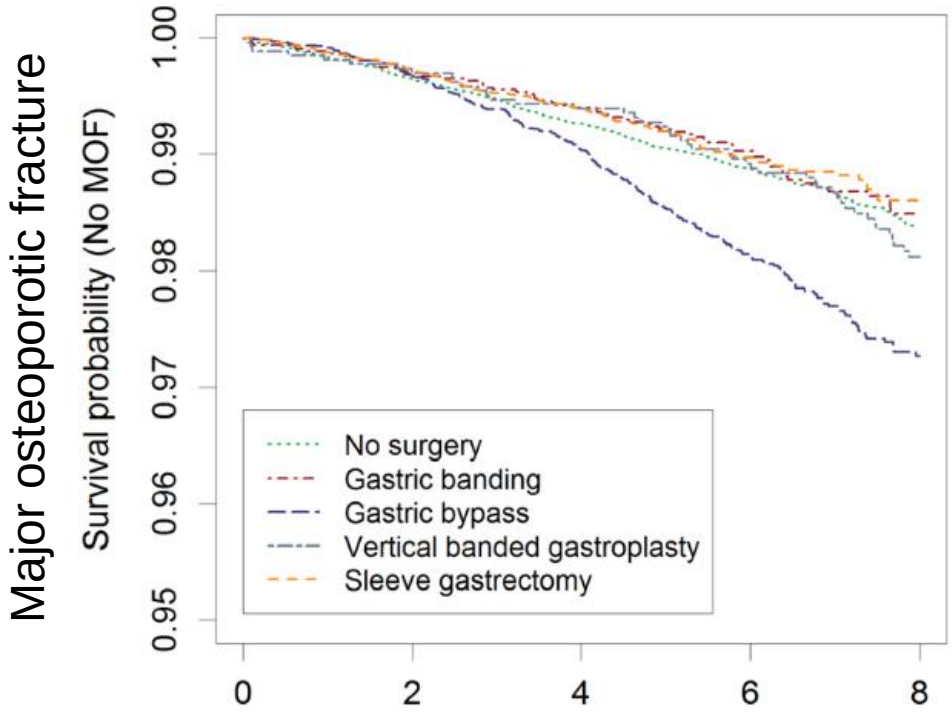
Fracture site	HR	95% CI
Hip	2.81	1.82-4.49
Pelvis	1.48	1.08-2.07
Wrist	1.70	1.33-2.14



Number at risk:	RYGB	29624	21202	15997	11314	7737	4946	2731	1095
	AGB	12721	9859	7985	6003	4300	2680	1371	448
Number of fractures:	RYGB	--	96	92	112	79	71	24	2
	AGB	--	31	42	31	28	19	11	4

Yu et al ENDO abstract 2018

Sleeve gastrectomy and fracture risk



	Number at risk (number of events)				
No surgery	40992 (0)	35534 (134)	32680 (266)	16757 (365)	0 (416)
Gastric banding	5178 (0)	5153 (16)	5124 (31)	3775 (48)	0 (64)
Gastric bypass	14532 (0)	14439 (49)	14311 (140)	7871 (246)	0 (292)
Vertical banded gastroplasty	2647 (0)	2625 (8)	2606 (16)	2435 (28)	0 (46)
Sleeve gastrectomy	18635 (0)	18535 (52)	18438 (111)	7580 (169)	0 (183)

0 2 4 6 8

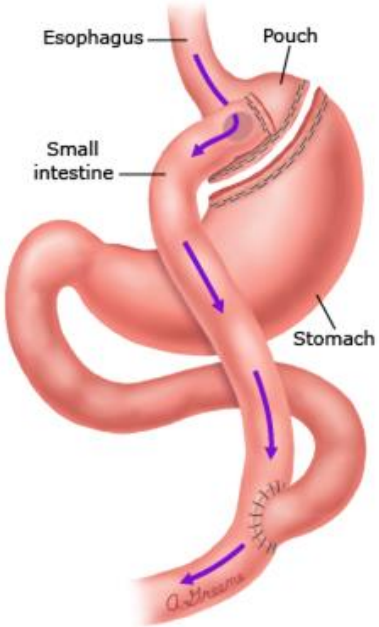
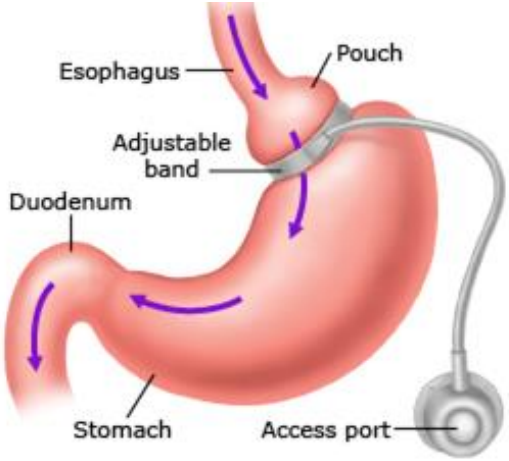
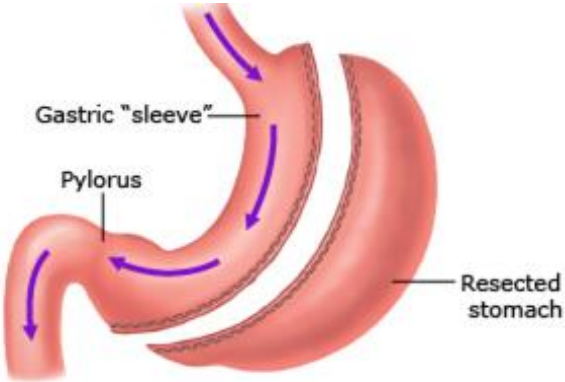
Years

Sleeve gastrectomy, HR 0.95
Gastric banding, HR 0.95
Obese controls

RYGB, HR 1.70 for MOF
HR 2.24 for Hip fx
HR 2.70 for Forearm fx

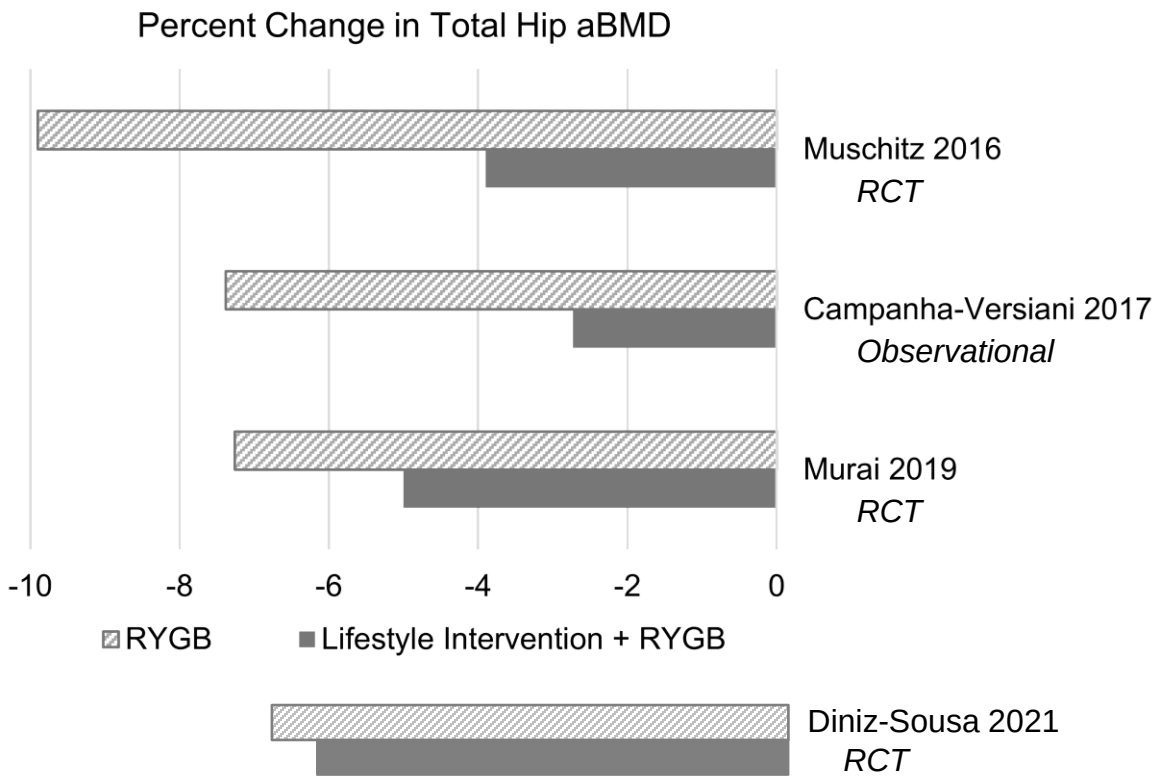
Paccou et al JBMR 2020

SUMMARY OF BONE OUTCOMES

	Roux-en-Y Gastric Bypass	Adjustable Gastric Band	Sleeve Gastrectomy
			
At 2 years post-op	5-7% spine bone loss 7-10% hip bone loss	No spine bone loss 2% hip bone loss	2-3% spine bone loss 5-7% hip bone loss
Fracture risk	~70% increase any fx 2-fold increase hip fx	No change in fracture risk	Possibly no change in fracture risk?

PREVENTION OF BONE LOSS AFTER BARIATRIC SURGERY

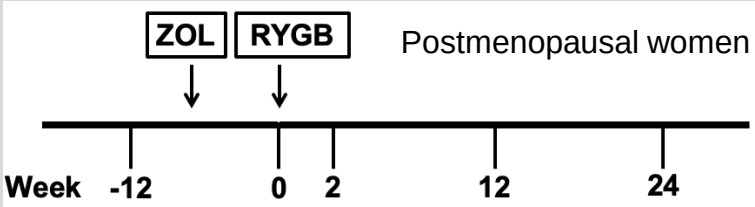
Exercise can partly prevent RYGB-bone loss

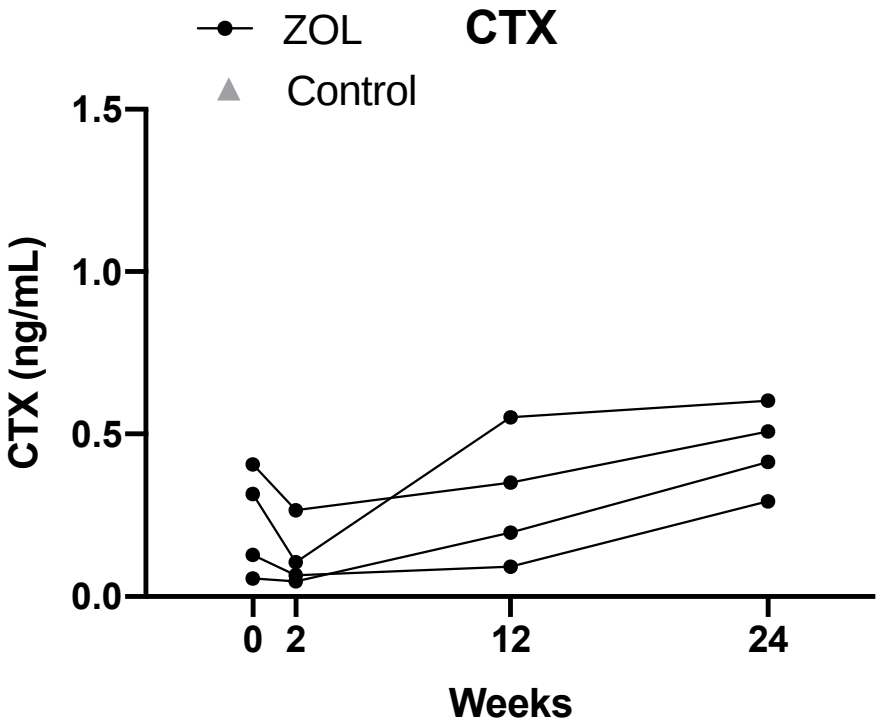


	Study Size	Study Length	Average Age
Muschitz 2016 *RCT*	220	24 months	41 years
Campanha-Versiani 2017 *Observational*	37	12 months	38 years
Murai 2019 *RCT*	70	6 months	41 years
Diniz-Sousa 2021 *RCT*	60	12 months	mid-40s

Beavers et al, Eur J Endo 2020
Diniz-Sousa et al, JBMR 2021

RYGB-Zoledronic acid pilot study



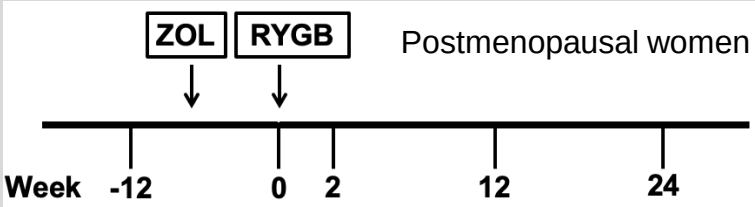


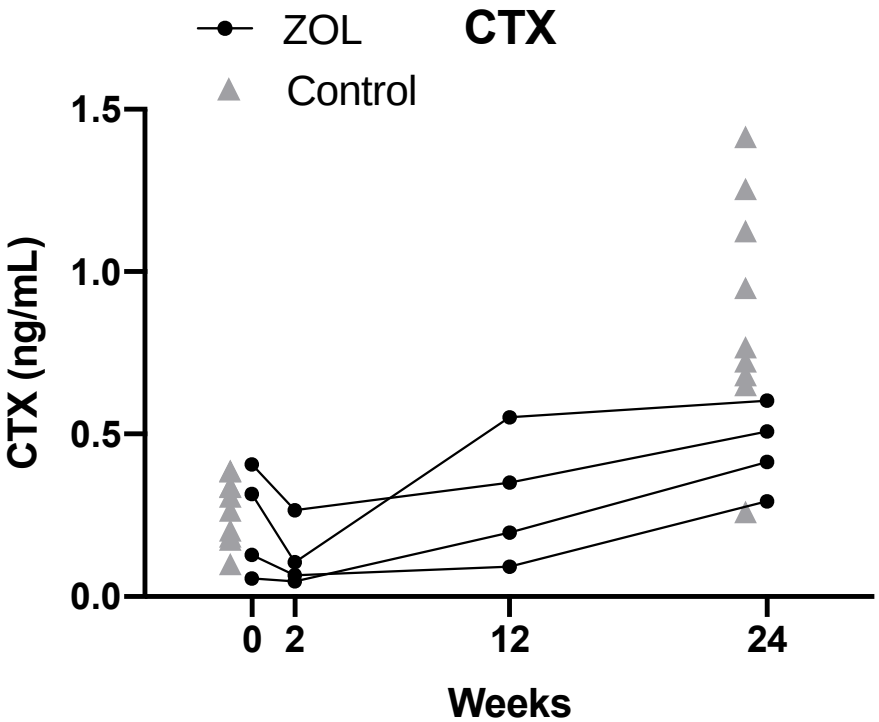
By 24 weeks:

- CTX levels above baseline despite ZOL (p=0.030)

Liu et al, ASBMR 2020 abstract

RYGB-Zoledronic acid pilot study



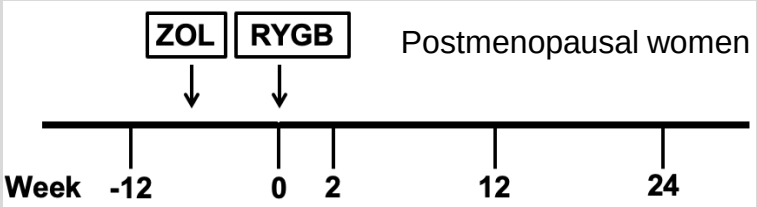


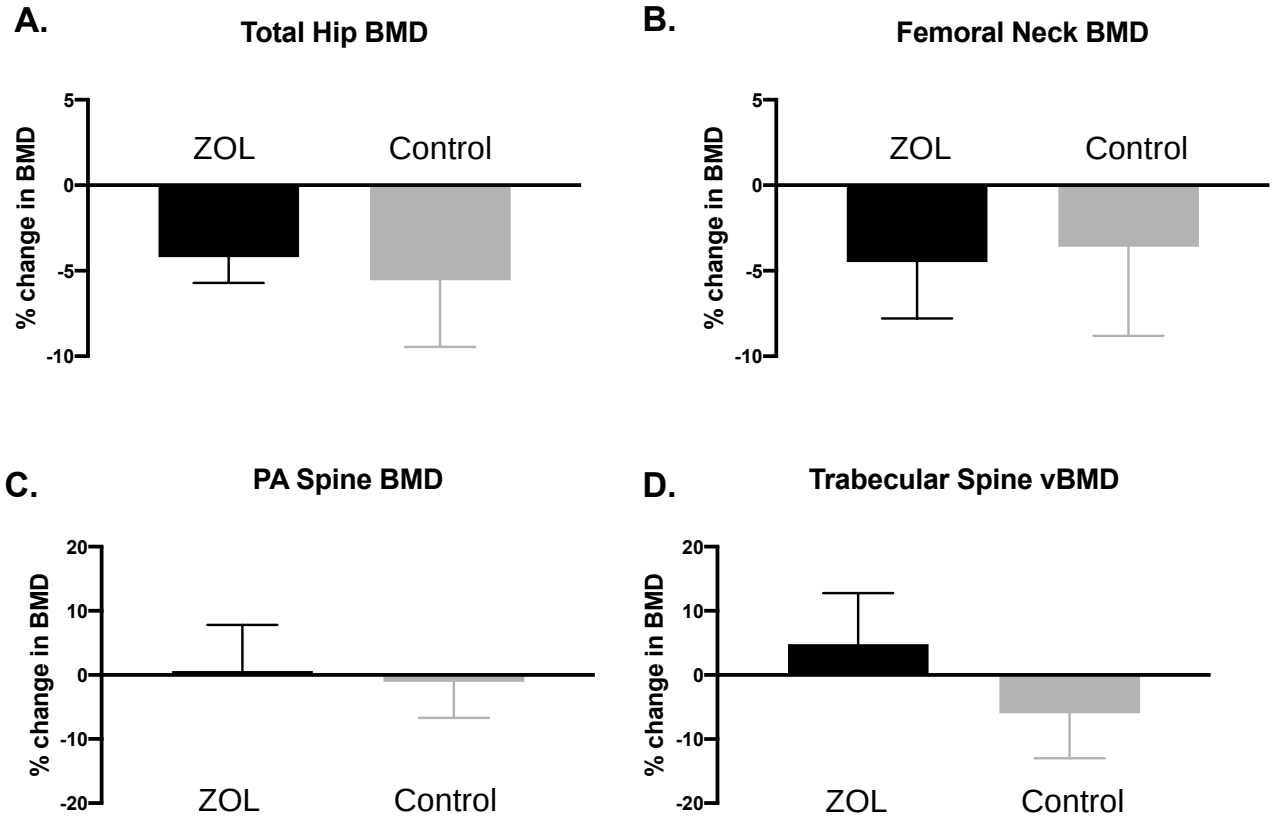
By 24 weeks:

- CTX levels above baseline despite ZOL (p=0.030)
- CTX levels in ZOL group lower than untreated controls (p=0.042)

Liu et al, ASBMR 2020 abstract

RYGB-Zoledronic acid pilot study





ZOL may be insufficient to prevent bone loss after RYGB

Liu et al, ASBMR 2020 abstract

Clinical considerations

- Management guidelines for bariatric surgery patients
  - » Calcium citrate ~1500mg/day
  - » Vitamin D ~3000 IU/day
  - » Physical activity, maintenance of lean mass
  - » Bone density screening for high-risk patients prior to bariatric surgery, and all patients after bariatric surgery

- Discussion of potential negative skeletal impact for patients

- Additional trials are needed to determine whether osteoporosis medications can prevent bariatric surgery induced bone loss (caution with oral bisphosphonates)

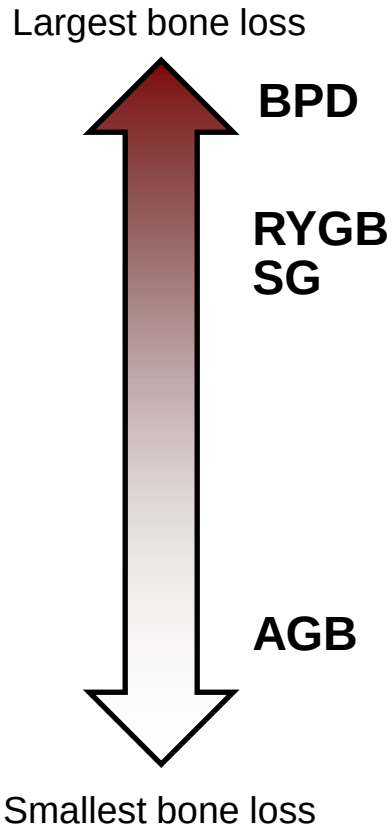
Case Presentation

- 47 year old woman with h/o RYGB with a right femoral neck fragility fracture and osteoporosis by DXA

- Management:
  - » Switched from calcium carbonate to calcium citrate and increased dose to 2000 mg / day
  - » Switched to ergocalciferol 50,000 IU / week
  - » Recommended increased regular weight-bearing exercise
  - » Started zoledronic acid 5 mg IV

Conclusions

- Bariatric surgery is highly effective for treating obesity but has the unintended consequence of accelerated bone loss
  - » Magnitude of effect varies by procedure
- RYGB increases risk of fractures by 40-60%, particularly hip and wrist fractures
  - » DXA screening and therapies should be considered
- Future research is required to evaluate treatment options to minimize high-turnover bone loss



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