Comparison of calcium citrate and calcium carbonate absorption in patients with a Roux-en-Y Gastric Bypass, Sleeve Gastrectomy, and One-Anastomosis Gastric Bypass:

A double-blind, randomized cross-over trial.

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Background

Bone Loss Counteraction:

Postoperative Ca supplementation, a vital micro-nutrient, has been shown to counteract potential bone loss and can be performed with different Ca salts, such as Ca carbonate or Ca citrate.

Research Gaps:

Existing studies (Tondapu et al.) lack statistical power and only performed in Roux-en-Y gastric bypass.
Need for comprehensive studies to establish guidelines (Smelt et al.)

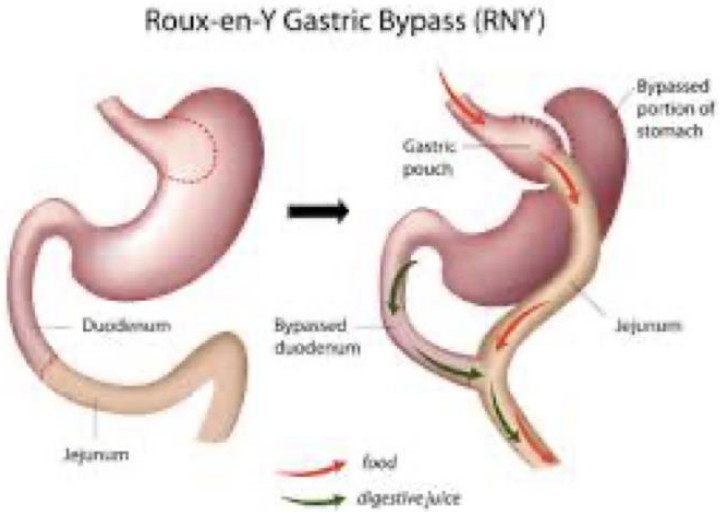
Future Directions:

Investigate Calcium absorption post-metabolic bariatric surgery (MBS) with rigorous statistics and diverse procedural considerations to enhance patient care.

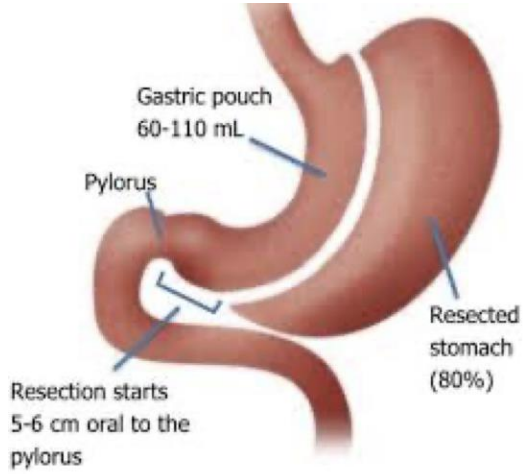
Tondapu P, Provost D, Adams-Huet B, Sims T, Chang C, Sakhaee K. Comparison of the Absorption of Calcium Carbonate and Calcium Citrate after Roux-en-Y Gastric Bypass. OBES SURG 2009;19:1256–61.
Smelt HJM, Pouwels S, Smulders JF. The Clinical Dilemma of Calcium Supplementation After Bariatric Surgery: Calcium Citrate or Calcium Carbonate That Is the Question? OBES SURG 2016;26:2781–2. https://doi.org/10.1007/s11695-016-2346-2.

Objective

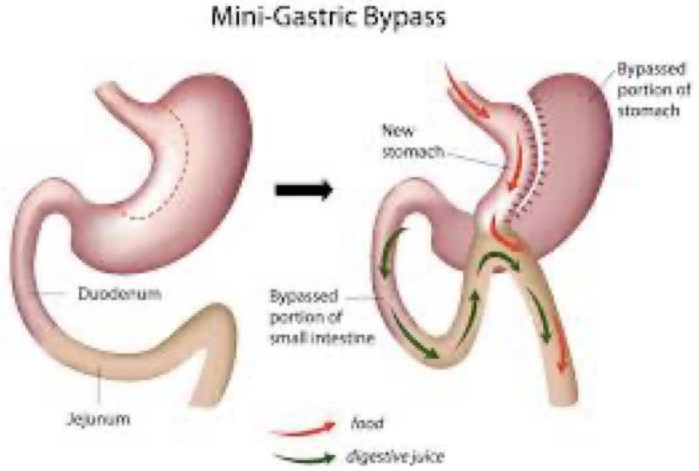
To assess the absorption effect between Ca citrate and Ca carbonate after MBS in:



Roux-en-Y gastric bypass (RYGB),

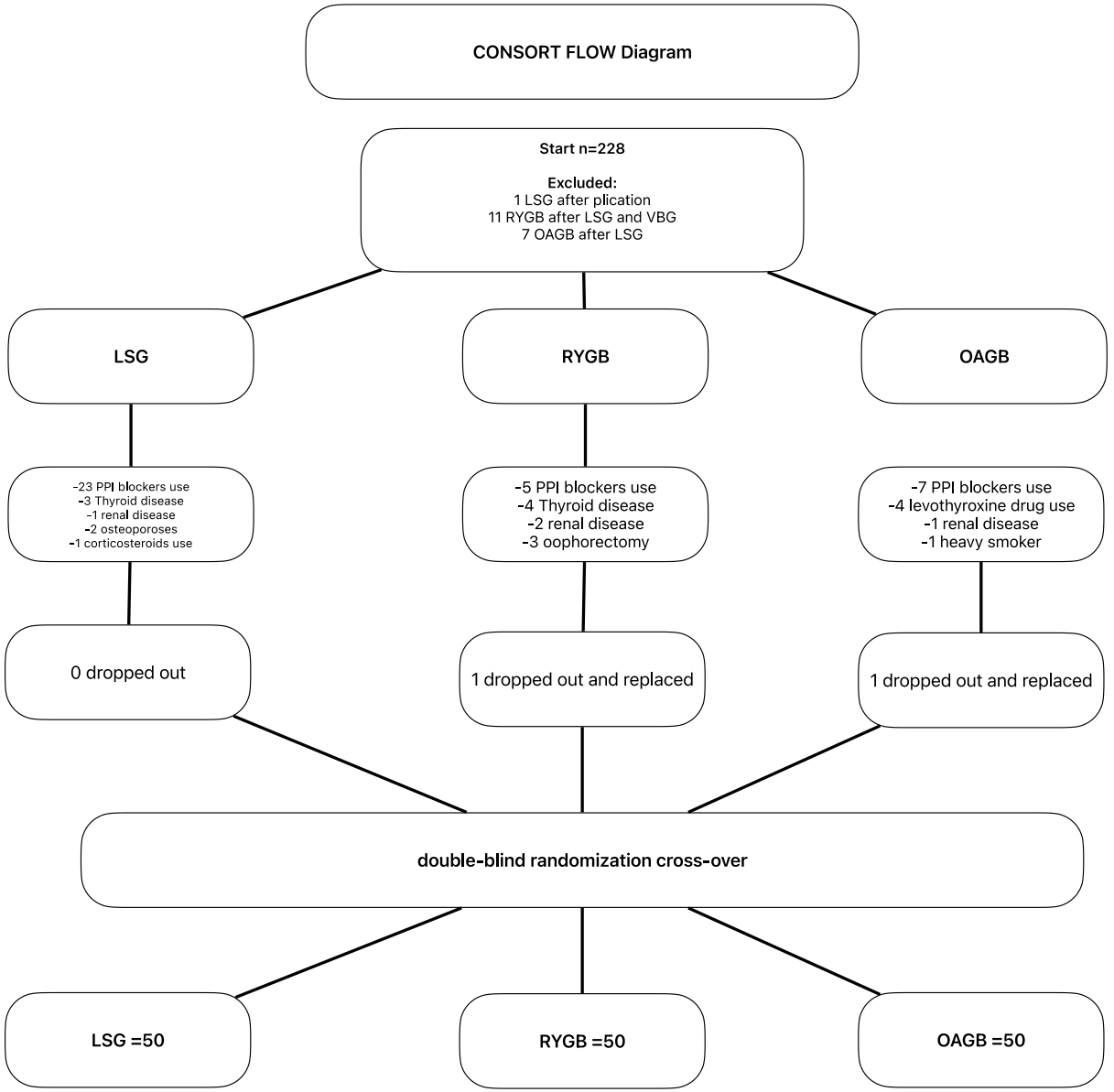


Laparoscopic Sleeve Gastrectomy (LSG),



One Anastomosis Gastric Bypass (OAGB)

Flowchart


CONSORT FLOW Diagram
Start n=228
Excluded:
1 LSG after plication
11 RYGB after LSG and VBG
7 OAGB after LSG
LSG
RYGB
OAGB
-23 PPI blockers use
-3 Thyroid disease
-1 renal disease
-2 osteoporoses
-1 corticosteroids use
-5 PPI blockers use
-4 Thyroid disease
-2 renal disease
-3 oophorectomy
-7 PPI blockers use
-4 levothyroxine drug use
-1 renal disease
-1 heavy smoker
0 dropped out
1 dropped out and replaced
1 dropped out and replaced
double-blind randomization cross-over
LSG =50
RYGB =50
OAGB =50

Methods

A randomized, double-blinded, crossover study
(with a 1-week wash-out period between crossover)

150 participants six months post-MBS were randomly selected.

The intestinal absorption of **Ca carbonate** and **Ca citrate** among groups divided by surgical procedure was compared over **8 hours of testing**

Serum and urine Ca concentrations for peak values **(C_{max})** and area under the curve **($AUC_{0\text{-}8h}$),** along with parathyroid hormone **(PTH)** levels to calculate minimum PTH **(PTH_{min})** and cumulative PTH decline **($AUC_{0\text{-}8h}$).**

Methods

Two type of supplements used

Supplement A: Elan “Calcium Chew chewable tablets”, marketed by WLSvital vof (Hessenweg 229, 3791PG ACHTERVELD, THE NETHERLANDS). Contains: Elemental calcium 500 mg (Ca citrate 2.381 g, 21%), and vitamin D3 (cholecalciferol) 20 mcg

Supplement B: Lucovitaal “Calcium 500mg & D3 Kauwtabletten”, marketed by PK Benelux BV (Vluchtoord 17, 5406XP UDEN, THE NETHERLANDS). Contains: Elemental calcium 500 mg (Ca carbonate 1.250 g, 40%), and vitamin D3 (cholecalciferol) 20 mcg.

Methods

At 6 A.M., empty their bladder ingested 600 mL of distilled water.

Then, at **7:30 A.M**., an intravenous line was placed

At **07:50 A.M**., randomization was applied for supplement A or B

Fasting blood samples were withdrawn **before** the gift of supplement A or B was administered.

Then, **after** the gift supplement A or B was ingested, another blood sample was taken to validate it

Consecutively every hour until 4 P.M. (8x extra in total) were sampled.

Subsequently, **after** each respective blood sample, participants consumed **300 mL of distilled water orally**

Statistical Analysis

Sample Size

Crude and adjusted Generalized Estimating Equation (GEE) analyses were conducted to estimate

GEE analyses were repeated while **adjusting** for the **surgery groups, age, sex, BMI**, and the **interaction between the Ca formulation**.

Hypotheses were measurement between factors of serum Ca with an estimated **less** absorption between 22-27% for carbonate.

A **conservative approach** was applied to avoid over-estimation,

1. an **effect size of 0.2** for eight measurements,
2. power of 0.8 with an alpha of 0.05,
3. 144 patients, rounded to 150 patients in total **(50 per MBS procedure)**

Results

1. Ca citrate demonstrated **superior** relative bioavailability,

1. **higher** AUC0-8h of **76.1 mg/dL·h** versus **74.7 mg/dL·h** for carbonate ($p = 0.001$)
2. **Cmax of 9.8 mg/dL** compared to **9.5 mg/dL** for carbonate ($p < 0.001$)

2. **Ca citrate** intake **significantly lowered parathyroid hormone (PTH)** levels and showed enhanced relative Ca bioavailability compared to **Ca carbonate**.

3. PTH levels were notably **reduced** from 3 to 6 hours post-administration with **Ca citrate,** ($p < 0.001$).

Results

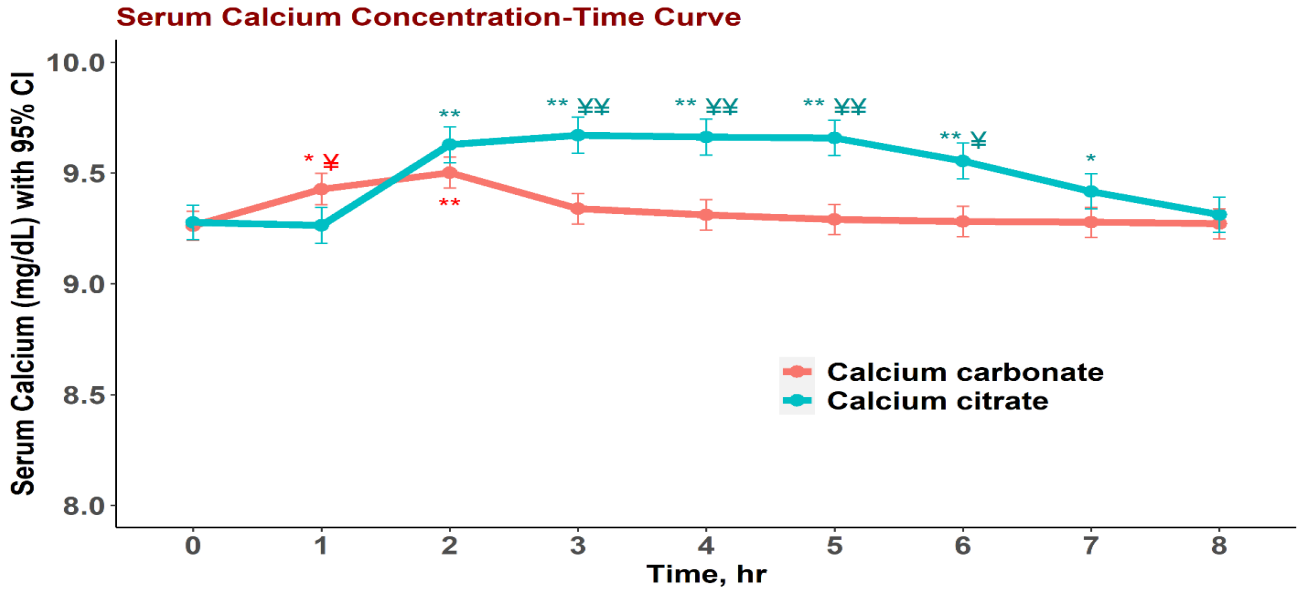
1. **Ca citrate** also demonstrated superior relative bioavailability

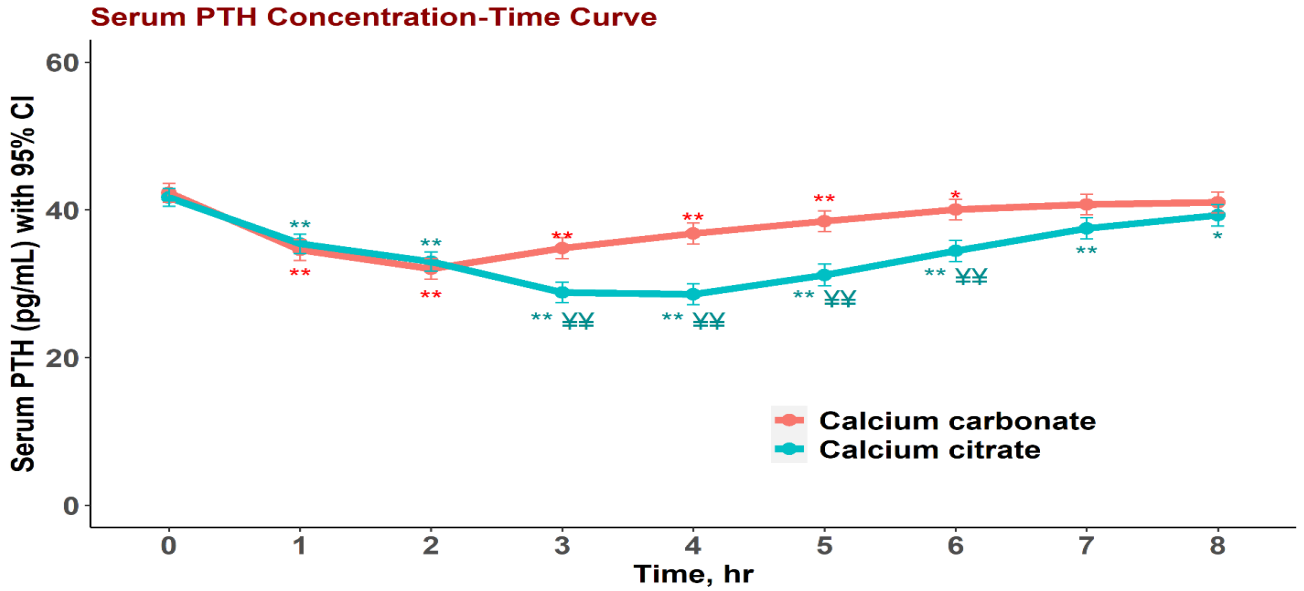
higher $AUC_{0\text{-}8h}$ of **76.1 mg/dL·h** versus **74.7 mg/dL·h** for **carbonate** (p = 0.001

2. C_{max} of **9.8 mg/dL** compared **to 9.5 mg/dL** for carbonate (p < 0.001)

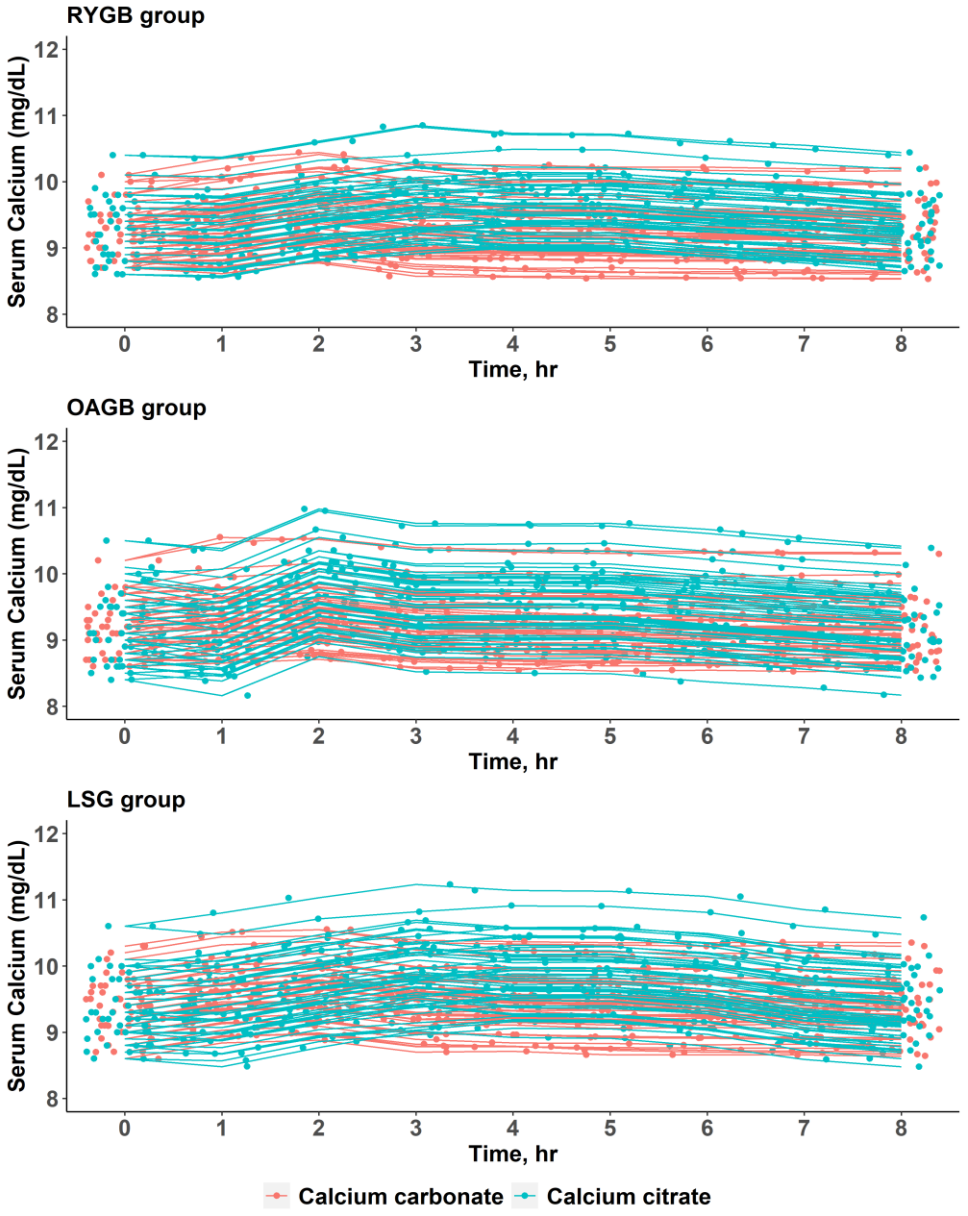
3. Urinary Ca excretion over **nine hours** was significantly greater in the citrate group at **83.7 mg/dL** compared to **68.6 mg/dL** for carbonate (p < 0.001).

Results


Serum Calcium Concentration-Time Curve
Serum Calcium (mg/dL) with 95% CI
10.0
9.5
9.0
8.5
8.0
0
1
2
3
4
5
6
7
8
Time, hr
Calcium carbonate
Calcium citrate


Serum PTH Concentration-Time Curve
Serum PTH (pg/mL) with 95% CI
60
40
20
0
0
1
2
3
4
5
6
7
8
Time, hr
Calcium carbonate
Calcium citrate

Results


RYGB group
OAGB group
LSG group
Serum Calcium (mg/dL)
Time, hr
Calcium carbonate
Calcium citrate

Limitation

1. Detailed data was **not collected on urinary Ca, phosphate, oxalate, and citrate excretion in 24-hour urine**

   samples might have given insight into the risk of renal stone formation

2. We **did not** evaluate the **long-term effects of Ca citrate and Ca carbonate on bone quality**

   Remains a crucial area for future research.

3. **Correcting for all potential confounding** factors that influence Ca metabolism **was not possible**,

   such as physical activity levels, alcohol consumption, and other nutritional deficiencies, supplements, or medications that affect bone and mineral metabolism

Conclusion

1. **Ca citrate was significantly better than carbonate with the adjustment for covariates,**
   In reducing PTH levels,
   Enhancing relative Ca bioavailability,
   Increasing urinary Ca excretion

2. **Citrate** resulted in **higher cumulative urinary Ca excretion** indicating better Ca absorption

3. **Further studies are necessary** to assess the clinical relevance of these findings

Thank you

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Clinical trial.gov: NCT06042985