

Hypocalcemia and Hypercalcemia

Calcium keeps muscles and nerves firing smoothly; when it's off, everything from your heartbeat to your brain misfires.

THE STORY IN ONE SENTENCE

Calcium keeps muscles and nerves firing smoothly; when it's off, everything from your heartbeat to your brain misfires.

“Too little or too much calcium both wreck nerves, muscles, and the heart. Find the upstream cause, fix it gently, and never ignore the warning signs.”

Normal anatomy — the body's job

Calcium floats in your blood at a steady level, held there by two main controllers: parathyroid hormone (PTH) from four tiny parathyroid glands tucked behind your thyroid, and active vitamin D made by your kidneys. These two work like a thermostat, pulling calcium out of bone, saving it in the kidneys, and helping your gut absorb it from food so nerves and muscles always have the exact amount they need to fire.

BODY'S JOB

Calcium is the spark plug for every nerve signal and every muscle squeeze, including your heartbeat. PTH watches blood calcium second by second; if it drops even a little, PTH yanks calcium out of bone (your body's calcium bank) and tells the kidneys to stop peeing it out. At the same time, PTH tells the kidneys to activate vitamin D, which then signals your gut to suck up more calcium from the food you eat. If calcium climbs too high, PTH shuts off and the kidneys dump the extra into urine. This loop keeps calcium locked in a narrow safe zone so your heart rhythm stays steady, your muscles contract smoothly, and your nerves don't fire randomly.

1. The four parathyroid glands (tiny rice-grain-sized glands on the back of your thyroid) sense blood calcium every second.
2. If calcium dips, the parathyroid glands release PTH into the blood.
3. PTH travels to your bones and tells bone-eating cells (osteoclasts) to dissolve a tiny bit of bone and dump calcium into the blood.

4. PTH also lands on kidney filters and tells them to hold onto calcium instead of peeing it out, and to activate vitamin D.
5. Active vitamin D goes to your gut and opens calcium gates in the intestine wall so calcium from food can cross into the blood.
6. All three actions—bone release, kidney save, gut absorb—push blood calcium back up.
7. When calcium is back to normal, the parathyroid glands sense it and stop releasing PTH, so the cycle pauses until calcium dips again.

What breaks

Calcium goes wrong when the controllers break or when something floods or drains the system faster than the controllers can adjust.

CLINICAL TERM

Low calcium (Hypocalcemia) (low calcium) happens when the parathyroid glands are removed or damaged during thyroid or parathyroid surgery, when they are naturally underactive (hypoparathyroidism), when vitamin D is missing (malabsorption, lack of sun, chronic kidney disease where kidneys can't activate it), when magnesium is too low (because you need magnesium to release PTH), when the pancreas is badly inflamed (acute pancreatitis traps calcium in dying fat), or during severe sepsis or critical illness (calcium drops for complex reasons including cytokine storms and protein binding shifts). High calcium (Hypercalcemia) (high calcium) happens when one or more parathyroid glands grow a tumor and pump out too much PTH (primary hyperparathyroidism), when cancer releases calcium by dissolving bone (multiple myeloma, breast or lung cancer bone metastases) or makes a PTH-like hormone called PTHrP (seen in lung, kidney, and other cancers), when diseases like sarcoidosis or tuberculosis make extra activated vitamin D inside immune cells (granulomatous disease), when someone takes toxic doses of vitamin D supplements, or when prolonged bed rest or immobilization releases calcium from bone faster than kidneys can clear it.

How the body compensates

The body has no good backup when calcium control fails—it can only try to keep nerves and muscles firing (in low calcium (hypocalcemia)) or protect the kidneys and brain (in high

calcium (hypercalcemia)) for a short window. Vital signs may look stable even as the system heads toward seizure, cardiac arrest, or coma, so you must catch the drift before the crash.

1. {'what': 'In low calcium (hypocalcemia), the nervous system becomes hyperexcitable', 'how': 'Low calcium makes nerve and muscle cell membranes leaky to sodium, so they fire with the tiniest trigger—muscles twitch, nerves tingle, and eventually the whole brain can seize.'}
2. {'what': 'The heart tries to repolarize but the ventricles take too long, stretching the QT interval on the EKG', 'how': 'Calcium is needed to close potassium channels and reset the heartbeat; without enough, repolarization drags out (long QT), risking a deadly spin called torsades de pointes.'}
3. {'what': 'In high calcium (hypercalcemia), the kidneys dump calcium into urine, pulling water with it', 'how': 'High blood calcium overwhelms the kidney's reabsorption capacity, causing excessive urination (polyuria) (lots of pee); water follows calcium out, so the patient becomes dehydrated, which then makes calcium climb even higher (vicious cycle).'} }
4. {'what': 'The brain and gut slow down as calcium floods cells', 'how': 'Too much calcium inside neurons blunts signals, causing confusion, lethargy, or coma; in the gut, it slows smooth-muscle contraction, causing constipation.'}
5. {'what': 'None of these compensations fix the root problem', 'how': 'Twitching muscles don't raise calcium; peeing more doesn't lower it enough if the source (hyperactive parathyroid, cancer) keeps pumping it in—so the body buys only minutes to hours before a critical threshold is crossed.'}
6. {'what': 'Watch the trajectory, not just the snapshot', 'how': 'A calcium of 7.5 mg/dL today that was 8.0 yesterday is more dangerous than a stable 7.5, because it tells you the system is losing the fight and a seizure or laryngospasm may be minutes away.'}
7. {'what': 'The crash points: low calcium (hypocalcemia) → laryngospasm, seizure, or torsades; high calcium (hypercalcemia) → severe dehydration, acute kidney injury, arrhythmia, or coma', 'how': 'Once any of these hits, the window to reverse it safely narrows fast—airway loss and cardiac arrest can happen in seconds.'}

Domino effect

1. Parathyroid glands fail or go haywire, or vitamin D is missing or toxic — PTH and vitamin D are the only two dials that control calcium—when either breaks, the whole system tips because there is no backup.
2. In low calcium (hypocalcemia), blood calcium drops below the threshold nerves and muscles need — Calcium normally plugs sodium leak channels in nerve and muscle membranes; when calcium falls, those channels open and cells fire on their own without a signal.

3. Muscles twitch and cramp (tetany), you feel tingling around the mouth and in the fingers (paresthesias), tapping the facial nerve makes the face twitch (Chvostek sign), and inflating a blood-pressure cuff causes the hand to spasm into a claw (Trousseau sign) — Every motor nerve is hyper-excitable, so even gentle touch or pressure triggers a full contraction—these signs prove the nervous system is on a hair trigger.
4. The voice box (larynx) can suddenly clamp shut (laryngospasm), or the whole brain seizes — The muscles around the vocal cords are especially sensitive to low calcium; when they spasm, the airway closes and the patient can't breathe. If the excitability spreads across the brain, synchronized firing causes a generalized tonic-clonic seizure.
5. The heart's ventricles take too long to reset after each beat, stretching the QT interval on the EKG and risking torsades de pointes (a chaotic, deadly rhythm) — Calcium closes potassium channels to end each heartbeat (repolarization); without enough calcium, potassium channels stay open longer, the ventricles reset slowly, and any extra beat can trigger a spiral into ventricular fibrillation.
6. In high calcium (hypercalcemia), the kidneys try to dump the flood of calcium, pulling massive amounts of water into the urine (polyuria) — High calcium in the kidney filters acts like an osmotic magnet, dragging sodium and water out with it—so the patient pees gallons and becomes severely dehydrated.
7. Dehydration makes calcium climb even higher, and the brain cells shrink, causing confusion, lethargy, or coma — As water leaves the body, blood calcium concentration rises further (less water to dilute it), and brain cells lose water too, so they can't fire signals properly—thinking gets foggy, then shuts down.
8. The gut slows to a crawl (constipation), kidney filters clog with calcium crystals (nephrocalcinosis, kidney stones), and bones ache as they dissolve — High calcium inside smooth-muscle cells in the gut wall makes them contract weakly, so stool barely moves. In the kidneys, calcium precipitates into hard crystals that scar the filters and form stones. Bones hurt because osteoclasts are chewing through them to release all that calcium into the blood.

Symptoms · what the patient feels, and why

- Muscle cramps and twitching (tetany): Calcium helps muscles relax after they squeeze. When calcium drops too low, nerves fire off extra signals and muscles stay tight or jerk on their own—especially in the hands, feet, and face.
- Tingling or numbness around the mouth, fingers, and toes (paresthesias): Nerves use calcium to send signals smoothly. Low calcium makes nerve cells jumpy, firing when they shouldn't, which feels like pins and needles or a buzzing sensation.

- Chvostek sign (face twitches when you tap the cheek): When calcium is low, the facial nerve becomes so sensitive that even a gentle tap in front of the ear makes the muscles around the mouth and nose jerk.
- Trousseau sign (hand cramps when a blood pressure cuff is inflated)
- Seizures: Calcium stabilizes the electrical activity in the brain. Severe low calcium (hypocalcemia) lets brain cells fire too easily, creating a storm of signals that shows up as a seizure.
- Long QT interval on ECG (heart rhythm change): Calcium helps heart muscle cells reset after each beat. Low calcium slows that reset, stretching out the electrical recovery time (the QT part of the heartbeat) and raising the risk of dangerous rhythms.
- Confusion or memory trouble: The brain depends on stable calcium to think clearly. Low calcium disrupts how brain cells talk to each other, making it harder to focus, remember, or reason.
- Weak, brittle bones or bone pain (in chronic low calcium (hypocalcemia)): When calcium stays low for a long time, the body pulls calcium out of bones to keep blood levels from falling even further. Over months or years, bones become soft and break more easily.
- Extreme thirst, frequent urination, and kidney stones (hypercalcemia): High calcium makes the kidneys work harder to filter it out, spilling extra calcium and water into the urine. The person pees a lot, gets dehydrated and thirsty, and calcium can clump into stones.
- Severe confusion, extreme weakness, or coma (hypercalcemic crisis): Very high calcium slows down nerve and muscle signals everywhere—including the brain. Thinking becomes foggy, muscles stop working well, and in the worst cases the brain shuts down into a coma.

Focused exam

- Chvostek sign — tap the facial nerve on the cheek, watch for facial muscle twitch: Low calcium makes nerves fire too easily, like a light switch that flips on before you even touch it. When calcium drops, nerves lose their safety brakes. This sign points directly to low calcium (hypocalcemia). A positive test (facial twitch when you tap) tells you the nerves are hyperexcitable right now.
- Trousseau sign — inflate blood pressure cuff above systolic pressure for 3 minutes, hand cramps into a claw: Same root cause as Chvostek: low calcium makes muscles fire without permission. Cutting off blood flow for a few minutes reveals the hidden overexcitability. This sign is more specific and harder to fake — it catches low calcium (hypocalcemia) even when Chvostek misses it.

- A high-pitched noise on breathing in (Stridor) or hoarse voice — laryngeal muscles tighten from low calcium: The voice box muscles can spasm and close the airway when calcium is critically low. This is laryngospasm. It can kill by suffocation. If you hear a high-pitched noise on breathing in (stridor) (a high-pitched squeaky breath sound), the patient needs IV calcium immediately.
- Tetany — involuntary muscle stiffness, cramps, or shaking in hands, feet, or face: Muscles fire in waves without control because calcium is too low to stabilize the muscle membrane. Tetany tells you the body has lost its electrical brakes on muscles. This is a hallmark of symptomatic low calcium (hypocalcemia) and means urgent treatment is needed.
- Tingling or numbness (Paresthesia) — tingling or pins-and-needles around mouth, lips, fingers, or toes: Nerves misfire when calcium drops, sending false signals that feel like buzzing or tingling. This is often the very first symptom a patient notices in early low calcium (hypocalcemia) — it shows up before the muscles start cramping.
- Prolonged QT interval on ECG — the heart's electrical cycle stretches too long: Low calcium slows the repolarization phase of the heart's electrical cycle (the part where heart cells reset after each beat). A long QT (corrected QT > 440–460 ms, depending on sex) raises the risk of torsades de pointes (a deadly spinning heart rhythm) and sudden cardiac arrest.

Diagnostics · every test answers a question

- Serum calcium — total and ionized (free) calcium → Is calcium actually low, or is this just a math trick from low albumin? Ionized calcium is the electrically active form that matters for nerves and muscles.
- Serum albumin → Is the total calcium low because albumin (the protein that carries calcium in blood) is low, or is ionized calcium truly low?
- Parathyroid hormone (PTH) — intact PTH → Are the parathyroid glands working? PTH is the body's main calcium-raising hormone. Is it appropriately high (trying to fix low calcium) or inappropriately low or high?
- 25-hydroxyvitamin D — the storage form of vitamin D → Does the body have enough vitamin D to absorb calcium from food and make PTH work? Vitamin D is the helper that lets calcium get into the blood.
- Serum magnesium → Is magnesium low? Magnesium is required for PTH to be released and for PTH to work at its receptor. Without magnesium, calcium stays low no matter what you do.
- Serum phosphate → Is phosphate high or low? Phosphate and calcium usually move in opposite directions. The pattern helps narrow the root cause.

- Serum creatinine and estimated GFR (eGFR) → Are the kidneys working? Kidneys activate vitamin D, reabsorb calcium, and dump phosphate. Kidney failure breaks all three.
- Electrocardiogram (ECG) → Is calcium affecting the heart's electrical system? The heart uses calcium to fire and reset. Too much or too little changes the rhythm.

Treatment logic

- IV calcium gluconate — 1-2 grams (10-20 mL of 10% solution) diluted in 50-100 mL normal saline, given over 10-20 minutes → Raises serum calcium immediately — within minutes. Stops muscle cramps, tetany, seizures, and tingling by restoring the calcium that nerves and muscles need to stabilize their membranes. Reverses the acute emergency and buys time to find the root cause.
- IV magnesium sulfate — 1-2 grams (2-4 mL of 50% solution) IV over 15 minutes, or oral magnesium oxide 400 mg twice daily if not urgent → Magnesium allows the parathyroid glands to release PTH and allows PTH to work at its target (bone, kidney, gut). Without magnesium, calcium will not rise no matter how much calcium or vitamin D you give. Replacing magnesium restarts the body's own calcium-control system.
- Oral calcium carbonate or calcium citrate — 1-2 grams elemental calcium daily in divided doses (e.g. 500 mg three times daily with meals) → Adds calcium directly to the blood by absorbing it from the gut. This is the long-term maintenance fix for chronic low calcium (hypocalcemia) (after parathyroid surgery, vitamin D deficiency, or chronic kidney disease). Works over days to weeks.
- Active vitamin D — calcitriol 0.25-0.5 mcg by mouth twice daily, or ergocalciferol (vitamin D2) 50,000 units weekly if deficiency is the cause → Calcitriol is the active form of vitamin D — it tells the gut to absorb more calcium and tells the kidneys to reabsorb calcium instead of peeing it out. Use calcitriol if kidneys cannot activate regular vitamin D (chronic kidney disease, hypoparathyroidism). Use ergocalciferol if the problem is low vitamin D stores. This fixes chronic low calcium (hypocalcemia) from vitamin D deficiency over weeks.
- IV normal saline — 200-300 mL/hour for several liters, then loop diuretic furosemide 20-40 mg IV once volume is restored → For high calcium (hypercalcemia): saline flushes calcium out through the kidneys by expanding blood volume and forcing the kidneys to dump calcium in the urine. Furosemide blocks calcium reabsorption in the kidney tubules. Together they lower calcium within hours. First-line for severe high calcium (calcium > 14 mg/dL) or symptomatic high calcium.
- Calcitonin — 4 units/kg IV or IM every 12 hours → For high calcium (hypercalcemia): calcitonin tells bone to stop breaking down (blocks osteoclasts, the cells that chew up bone and release calcium). Also tells kidneys to dump calcium in urine. Lowers calcium within 4-6 hours. Use for urgent high calcium when calcium is dangerously high (> 14 mg/dL) or causing confusion, arrhythmias, or severe symptoms.

- Bisphosphonate — zoledronic acid 4 mg IV over 15 minutes, or pamidronate 60–90 mg IV over 2–4 hours → For high calcium (hypercalcemia) from cancer or excess bone breakdown: bisphosphonates poison the osteoclasts (bone-chewing cells) so bone stops releasing calcium. Lowers calcium over 2–4 days and lasts weeks. Used for high calcium of malignancy or severe primary hyperparathyroidism when surgery is delayed.

Medications

Calcium gluconate (IV) · Intravenous calcium salt

Gives the body calcium directly through a vein when the blood level has dropped so low that nerves and muscles are starting to misfire — think shaking, spasms, or a heart that skips beats. It is the fastest way to boost calcium and calm those electrical signals so the heart can beat steadily and muscles can relax.

1. The nurse or doctor gives the calcium salt slowly through an IV line into a vein
2. The calcium dissolves into the blood within minutes
3. Calcium ions latch onto receptors on nerve and muscle cells, calming their overactive signals
4. The heart's electrical system steadies, and muscle spasms ease or stop
5. Blood calcium rises quickly, usually within 10–15 minutes

SAFETY WATCH

Must be given slowly; too fast can make the heart stop or beat dangerously slow · The IV line must be placed correctly — if the medicine leaks into tissue around the vein, it can burn and damage skin · Check the heart rhythm (EKG) during the infusion, especially if the patient takes digoxin (a heart drug), because calcium can make digoxin toxic · Measure blood calcium and magnesium levels right after and then regularly to guide the next dose

Calcium carbonate or calcium citrate (oral) · Oral calcium supplement

Gives the body calcium through pills taken by mouth when the low calcium is mild or the person is recovering and just needs a steady daily refill. The gut absorbs the calcium, and the blood level climbs slowly over hours and days.

1. The person swallows the calcium pill with food (for carbonate) or any time (for citrate)
2. Stomach acid breaks the pill apart and releases calcium ions
3. The small intestine absorbs the calcium, especially if vitamin D is present to help
4. The calcium enters the bloodstream and travels to cells that need it

5. Over days to weeks, blood calcium rises and stays steady if the person keeps taking the pills

SAFETY WATCH

Take with vitamin D (either in the same pill or separately) so the gut can actually absorb the calcium · Can cause constipation or stomach upset; citrate is gentler on the stomach than carbonate · Too much calcium over time can lead to kidney stones or deposits in blood vessels, so follow the dose your doctor gives · Check blood calcium every few weeks at first to make sure the level is climbing but not going too high

Calcitriol (active vitamin D) · Active vitamin D hormone

Turns on the body's calcium-absorbing machinery in the gut and tells the kidneys to hold onto calcium instead of peeing it out. Calcitriol is the final, ready-to-work form of vitamin D — the form that actually flips the switches in cells.

1. The person takes calcitriol by mouth (usually a small capsule once or twice a day)
2. The drug enters the bloodstream and travels to the gut, kidneys, and bones
3. In the gut, calcitriol binds to vitamin D receptors inside intestinal cells and tells them to make calcium-transport proteins
4. Those proteins grab calcium from digesting food and shuttle it into the blood
5. In the kidneys, calcitriol tells the tubules (the kidney's tiny filters) to pull calcium back from urine
6. Over days, blood calcium climbs as more is absorbed and less is lost

SAFETY WATCH

Too much can push calcium too high, leading to confusion, kidney stones, or calcium deposits in soft tissues · Check blood calcium and phosphate every 1–2 weeks when starting, then monthly once stable · Tell your doctor if you feel very thirsty, urinate a lot, or feel confused — these can be signs calcium is climbing too high · Avoid taking extra vitamin D supplements without asking, because calcitriol is already the strongest form

Magnesium sulfate (IV) or magnesium oxide (oral) · Magnesium replacement

Refills the body's magnesium tank. Magnesium is needed for the parathyroid glands (four tiny glands in the neck) to release parathyroid hormone (PTH), and PTH is what tells bones and kidneys to keep blood calcium normal. Without magnesium, the parathyroid glands go silent, calcium drops, and replacing calcium alone will not fix it — you must replace magnesium first.

1. For severe low magnesium, the doctor gives magnesium sulfate through an IV; for mild cases, the person takes magnesium pills

2. Magnesium enters the bloodstream
3. The parathyroid glands sense the magnesium and start releasing PTH again
4. PTH signals bones to release calcium and kidneys to reclaim calcium from urine
5. Blood calcium begins to rise, usually within hours to a day after magnesium is restored
6. Magnesium also directly steadies nerve and muscle cell membranes, reducing twitching and spasms

SAFETY WATCH

IV magnesium must be given slowly; too fast can drop blood pressure suddenly or make the heart beat irregularly · Oral magnesium (especially oxide) often causes loose stools or diarrhea; taking it with food or switching to magnesium citrate can help · Check blood magnesium and calcium levels during treatment · Tell your doctor if you have kidney disease — damaged kidneys cannot clear extra magnesium, and it can build up to dangerous levels

Normal saline (IV fluids) · Intravenous crystalloid solution (for high calcium)

Floods the bloodstream with salt water to dilute the calcium and flush extra calcium out through the kidneys in urine. High calcium makes people urinate a lot, which leads to dehydration, and dehydration makes calcium climb even higher — IV fluids break that cycle.

1. A nurse places an IV line and runs normal saline (salt water) at a steady, often brisk rate
2. The fluid fills the blood vessels, thinning the blood and lowering the concentration of calcium
3. The kidneys filter the extra fluid and calcium and dump it into urine
4. Blood calcium starts to fall within hours, and urine output increases
5. Fluids are continued until calcium drops to a safer range and the person can drink enough on their own

SAFETY WATCH

Too much fluid too fast can overload the heart and lungs, especially in older adults or people with heart failure — watch for sudden shortness of breath or leg swelling · Check blood calcium, sodium, and potassium levels daily during treatment · Monitor urine output to make sure the kidneys are actually flushing calcium · Stop or slow fluids if the person develops trouble breathing, swelling, or oxygen levels drop

Calcitonin (injection) · Hormone that lowers blood calcium (for high calcium)

Tells bone cells to stop releasing calcium into the blood and tells the kidneys to dump more calcium into urine. Calcitonin is a natural hormone made by the thyroid gland; the drug version is a synthetic copy. It works within hours — the fastest non-IV option for high calcium.

1. The nurse or patient gives calcitonin as a shot under the skin or into a muscle, or sometimes as a nasal spray (though the shot works faster)
2. The drug travels through the blood to bones and kidneys
3. In bone, calcitonin locks onto osteoclast receptors and stops those cells from dissolving bone and spilling calcium
4. In the kidneys, calcitonin blocks calcium reabsorption, so more calcium leaves in urine
5. Blood calcium starts to drop within 2–4 hours
6. The effect lasts about 6–8 hours, then the body adapts and calcitonin stops working well (called tachyphylaxis)

SAFETY WATCH

Common side effects: nausea, flushing (warm, red face), and mild stomach cramps · Rarely, people allergic to salmon (because the drug is made from salmon calcitonin) may have a reaction — tell your doctor about fish or shellfish allergies · Works best when combined with IV fluids · Blood calcium should be checked every 4–6 hours at first

Zoledronic acid (IV bisphosphonate) · Bisphosphonate (bone-hardening drug for high calcium)

Sticks to bone and poisons the osteoclasts (the cells that chew up bone and release calcium). This stops bones from dumping calcium into the blood. It works slowly but lasts weeks — the workhorse for cancer-related high calcium.

1. A nurse gives zoledronic acid as a single IV infusion over 15–30 minutes
2. The drug circulates in the blood and quickly latches onto bone surfaces, especially where bone is actively being broken down
3. Osteoclasts attach to bone and start dissolving it to release calcium
4. As they work, they absorb the bisphosphonate
5. Inside the osteoclast, the drug blocks a key enzyme (farnesyl pyrophosphate synthase) needed for the cell to survive
6. The osteoclast dies, bone breakdown stops, and calcium release into the blood slows
7. Blood calcium begins to fall in 2–4 days and reaches its lowest point around day 7
8. The effect lasts 2–4 weeks or longer

SAFETY WATCH

Can cause flu-like symptoms (fever, aches, chills) 1–3 days after the infusion, especially the first time; acetaminophen or ibuprofen usually help · Rarely, it can damage the jawbone (osteonecrosis of the jaw), especially after dental surgery or tooth extraction — see a dentist before starting if possible, and avoid invasive dental work while on the drug · Can harm the kidneys — make sure the person is well-hydrated before and after, and check kidney function · Check calcium, phosphate, magnesium, and kidney labs before the infusion and then regularly · Very rarely causes an irregular heartbeat (atrial fibrillation)

Denosumab (injection) · RANKL inhibitor (bone-protection drug for high calcium)

Blocks RANKL, a protein signal that tells baby bone cells to grow up into osteoclasts (the bone-dissolving cells). Without that signal, fewer osteoclasts form, bone breakdown slows, and less calcium spills into the blood. It works faster than bisphosphonates and does not depend on the kidneys.

1. A nurse or the patient gives denosumab as a shot under the skin (usually in the thigh, belly, or upper arm)
2. The drug circulates and binds tightly to RANKL proteins floating in the blood and bone environment
3. RANKL can no longer dock onto its receptor (RANK) on bone cell surfaces
4. Without that signal, precursor cells do not mature into osteoclasts
5. Existing osteoclasts slow down and die off naturally
6. Bone breakdown drops sharply, and calcium release into the blood falls
7. Blood calcium starts to decline within 1–2 days and reaches its lowest point around day 10
8. The effect lasts several weeks

SAFETY WATCH

Low calcium can happen days to weeks after the shot, especially if vitamin D is low or the person has kidney disease — check calcium, vitamin D, and magnesium before and after, and replace them if needed · Rarely causes osteonecrosis of the jaw (same risk as bisphosphonates) — avoid invasive dental work while on it · Rarely causes unusual fractures of the thigh bone if used for a very long time · Make sure the person takes calcium and vitamin D supplements daily unless told otherwise · Check blood calcium every few days at first, then weekly

Prednisone or hydrocortisone (corticosteroid) · Corticosteroid (for high calcium caused by too much vitamin D or certain cancers)

Blocks the gut from absorbing calcium and stops certain white blood cells (like those in lymphoma or sarcoidosis) from making too much active vitamin D. High vitamin D forces the gut to soak up calcium like a sponge; steroids slam the brakes on that process.

1. The person takes prednisone pills by mouth (or the doctor gives hydrocortisone IV if the person cannot swallow)
2. The steroid enters cells in the gut and immune system
3. In the gut, it blocks vitamin D receptors and reduces production of calcium-binding proteins
4. Calcium absorption from food drops
5. In overactive immune cells, the steroid shuts down the enzyme making extra vitamin D
6. Active vitamin D levels fall, which further reduces gut calcium absorption
7. Blood calcium starts to drop in 2-5 days

SAFETY WATCH

Short-term use (days to a few weeks) is usually safe, but can raise blood sugar, cause insomnia, increase appetite, and make mood swing · Long-term use (months) can weaken bones, raise infection risk, cause weight gain, high blood pressure, and cataracts — so use the lowest dose for the shortest time · Never stop steroids suddenly after more than a week or two of use; the dose must be tapered down slowly · Check blood sugar and blood pressure regularly · Watch for signs of infection (fever, cough, painful urination)

Hemodialysis (for life-threatening high calcium) · Renal replacement therapy / extracorporeal blood filtration

Runs the blood through a machine that acts as an artificial kidney, pulling calcium (and other waste) out of the blood directly and dumping it into dialysis fluid. This is the fastest way to drop calcium when it is so high that the heart or brain is in immediate danger and drugs are too slow.

1. A doctor places a large IV catheter (dialysis catheter) into a vein in the neck, chest, or groin
2. Blood is pumped out of the body into the dialysis machine
3. Inside the dialyzer, blood flows on one side of a thin membrane, and calcium-free dialysis fluid flows on the other side
4. Calcium (along with other waste) crosses the membrane from blood into the dialysis fluid
5. The cleaned blood, now with much lower calcium, flows back into the person's body
6. The process runs for 3-4 hours
7. Blood calcium drops sharply during and right after the session

SAFETY WATCH

Requires a large catheter in a central vein, which carries risk of bleeding, infection, or puncturing nearby structures (lung, artery) · During dialysis, blood pressure can drop suddenly — the team watches closely and may give fluids or medications to keep pressure stable · Calcium can swing too low during or after dialysis, causing muscle cramps, tingling, or (rarely) seizures — calcium is checked every 1–2 hours · Risk of infection at the catheter site — the site is cleaned carefully and watched for redness, drainage, or fever · Only done in a hospital intensive care unit with experienced dialysis staff

Red flags

- Seizure or severe muscle spasms that won't stop
- Chest pain, fast heartbeat, or fainting (signs the heart rhythm may be dangerous)
- Severe confusion, trouble waking up, or coma
- Very high calcium (above 14 mg/dL) or very low calcium (below 7 mg/dL with symptoms)
- Sudden severe belly pain, vomiting, or signs of pancreatitis (which high calcium can trigger)

Nursing priorities

1. Place patient on continuous cardiac monitor and watch for prolonged QT interval on ECG (electrocardiogram, the heart tracing) — Low calcium lengthens the QT interval and can trigger torsades de pointes (a deadly spinning heart rhythm); high calcium shortens QT and causes a slow heart rate (bradycardia) (slow heart rate) or heart block
2. Check Chvostek sign (tap the facial nerve in front of the ear) and Trousseau sign (inflate blood pressure cuff above systolic pressure for 3 minutes and watch for hand spasm) — Positive signs mean nerves are hyperexcitable from low ionized calcium (the active form); this warns that seizures or airway spasm could happen soon
3. Keep IV calcium gluconate 1 to 2 grams at the bedside and ensure a patent large-bore IV line is in place — Severe low calcium can cause laryngospasm (vocal cord spasm blocking the airway) or seizures within minutes; immediate IV calcium reverses the muscle spasm and saves the airway
4. Draw blood for ionized calcium, albumin, magnesium, phosphorus, PTH (parathyroid hormone), and vitamin D levels before giving treatment — Total calcium is affected by albumin (the protein that carries calcium); ionized calcium is the true number; low magnesium blocks PTH release and must be fixed first or calcium will not rise

5. Administer IV calcium gluconate slowly over 10 to 20 minutes through a large vein and never push it fast — Rapid IV calcium causes a slow heart rate (bradycardia) and cardiac arrest; calcium is also caustic (burns tissue) and will cause skin tissue death (necrosis) (tissue death) if it leaks outside the vein
6. Replace magnesium sulfate 1 to 2 grams IV over 15 minutes if serum magnesium is below 1.8 mg/dL — Magnesium is required for the parathyroid glands to release PTH; low calcium will not correct until magnesium is normal; low magnesium also causes the same muscle twitching and seizures
7. For high calcium above 14 mg/dL, give normal saline IV at 200 to 300 mL per hour and monitor urine output closely — High calcium causes severe dehydration because the kidneys cannot concentrate urine; IV fluids dilute the calcium and help kidneys excrete it; dehydration makes calcium climb even higher
8. Encourage mobilization and weight-bearing activity as soon as safe, and avoid bed rest — Immobility causes bones to release calcium into the blood; movement signals bones to hold onto calcium and lowers blood levels naturally

Sources

- Endocrine Society Clinical Practice Guideline 2016
- UpToDate Clinical Reference (Endocrinology)
- American Association of Clinical Endocrinology
- NEJM Clinical Practice

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