



# Association between bone mineral density and hearing loss in Osteogenesis Imperfecta

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FACULTEIT GENEESKUNDE EN  
GEZONDHEIDSWETENSCHAPPEN

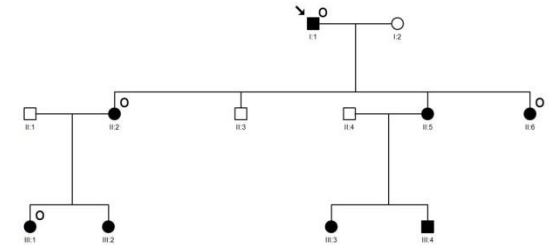
Universitair Ziekenhuis Gent



# I. Introduction

## Osteogenesis Imperfecta (OI) - Hearing loss

- ❑ 50 % of OI patients
- ❑ OI types I, III, IV
- ❑ Mild to profound hearing loss, progressive
- ❑ Intrafamilial variability
- ❑ Hearing loss type:



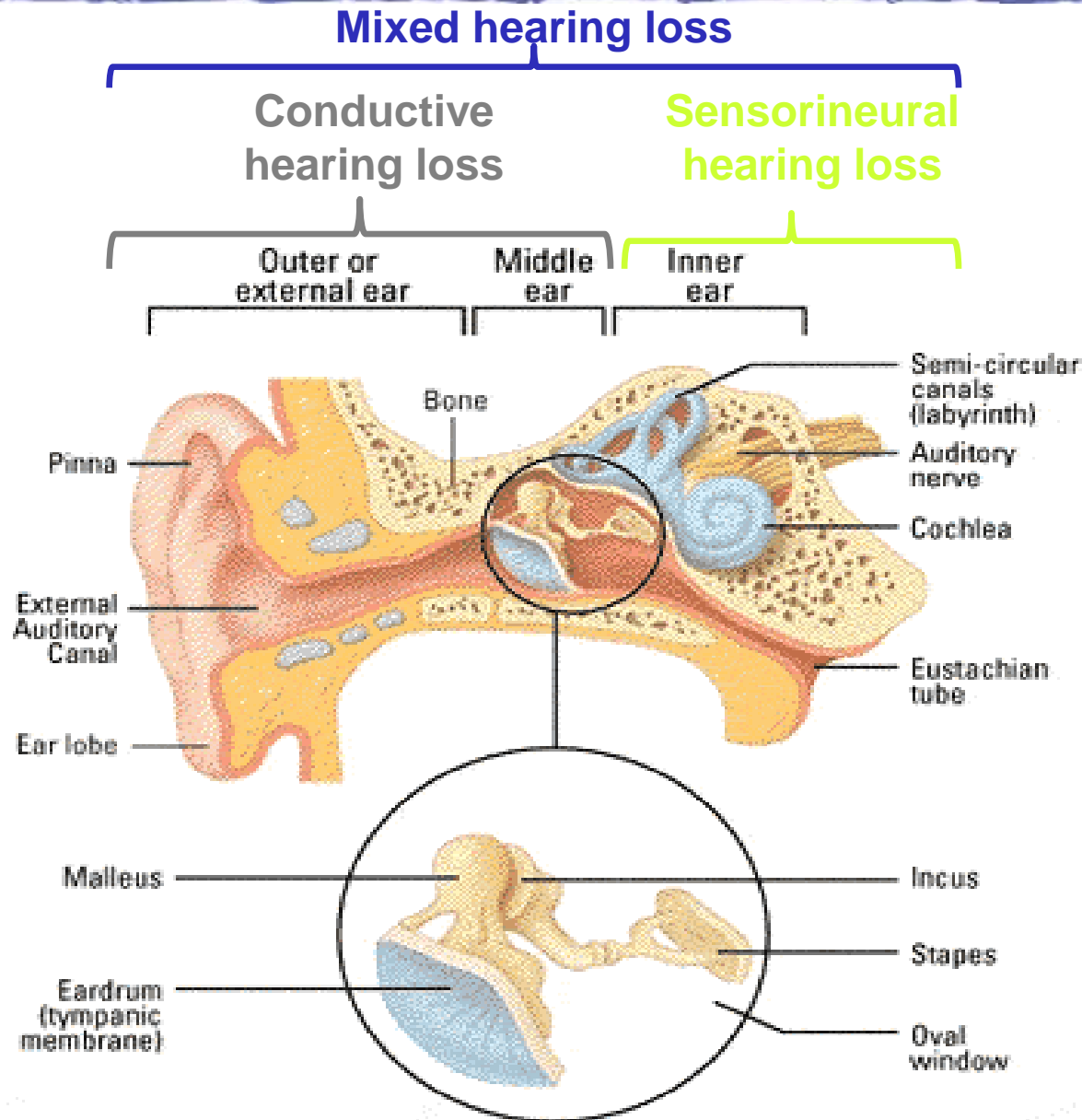
Conductive hearing loss

Mixed hearing loss

Pure high-frequency  
sensorineural hearing  
loss

Pure sensorineural  
hearing loss

## OI - Hearing loss (2)



## OI - Hearing loss (3)

### Conductive – Mixed

- ❑ Otosclerosis-like lesions: stapes footplate fixation (and pericochlear lesions)
- ❑ Ossicular discontinuity (fractured/atrophic ossicles)

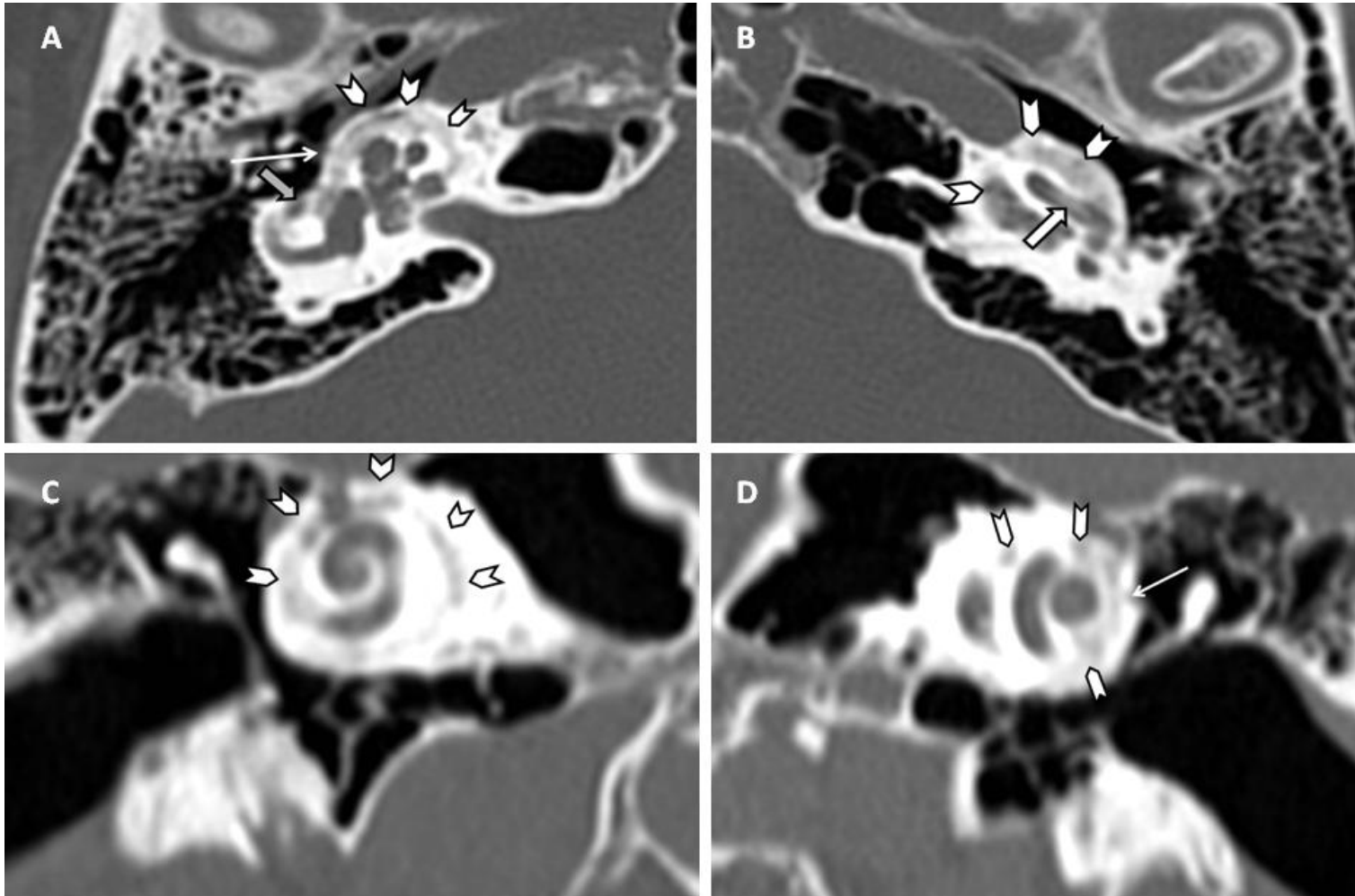
### Pure sensorineural loss

- ❑ Cochlear hair cell atrophy
- ❑ Atrophy stria vascularis
- ❑ Perilymphe hemorrhage

# I. Introduction

## Computed tomography temporal bones

Bilaterally severely progressed mixed hearing loss in a 67-year old OI-patient:  
severe pericochlear demineralization of bone



## Research aim

- ❑ Relationship between occurrence/type of hearing loss and generalized bone disease?
- ❑ Heterogeneity of hearing loss explained by variability in bone characteristics?



### Patients and materials

- ❑ 56 adult OI patients (F: 34 M: 22) with identified mutation in *COL1A1* or *COL1A2*
  - ❑ Mean age: 43 y. (SD 13.7)
  - ❑ Bisphosphonates administration excluded
  
- ❑ Audiological evaluation
  - ❑ Pure-tone audiometry
  - ❑ Admittance measurements
  - ❑ Stapedius reflex measurements
  
- ❑ Bone mineral density (BMD) measurements

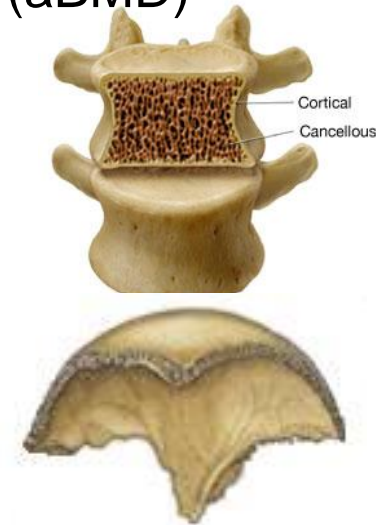
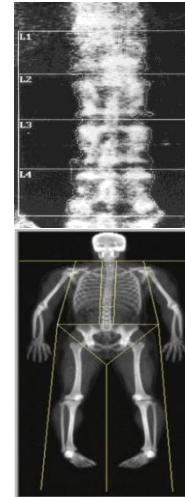


## II. Methods

### Bone mineral density measurements

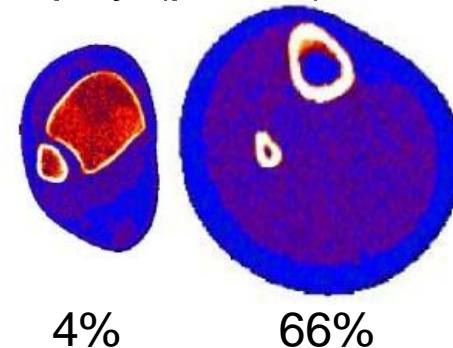
#### ❑ Dual X-ray absorptiometry (DXA): areal BMD (aBMD)

- Lumbar spine  
**trabecular bone aBMD**
- Whole body  
**cortical bone aBMD**



#### ❑ Peripheral quantitative computed tomography (pQCT): volumetric BMD (vBMD)

- Radial metaphysis (4%)  
**trabecular bone vBMD**
- Radial diaphysis (66%)  
**cortical bone vBMD**

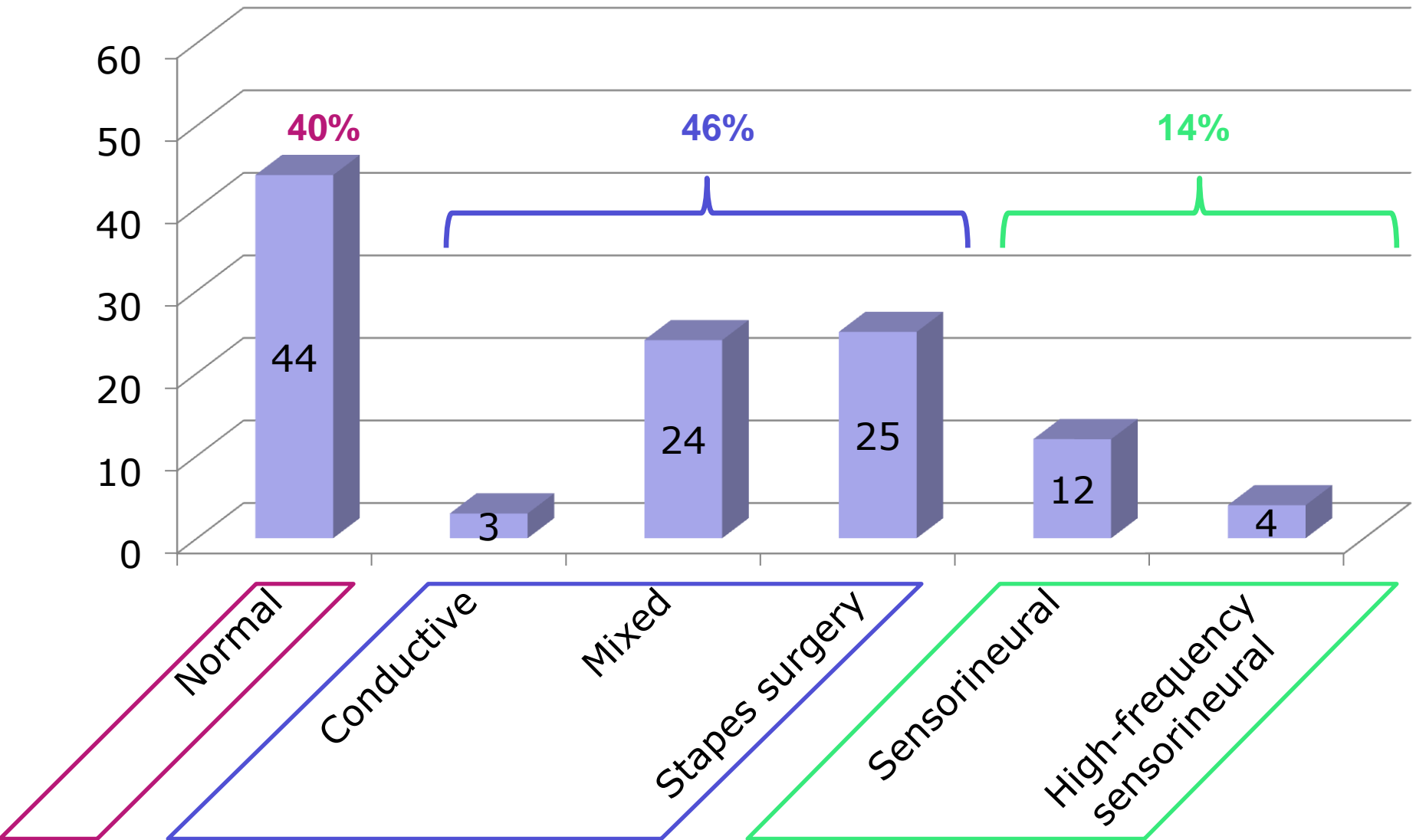


bone geometry parameters: **cortical thickness, periosteal circumference, endosteal circumference**



# III. Results

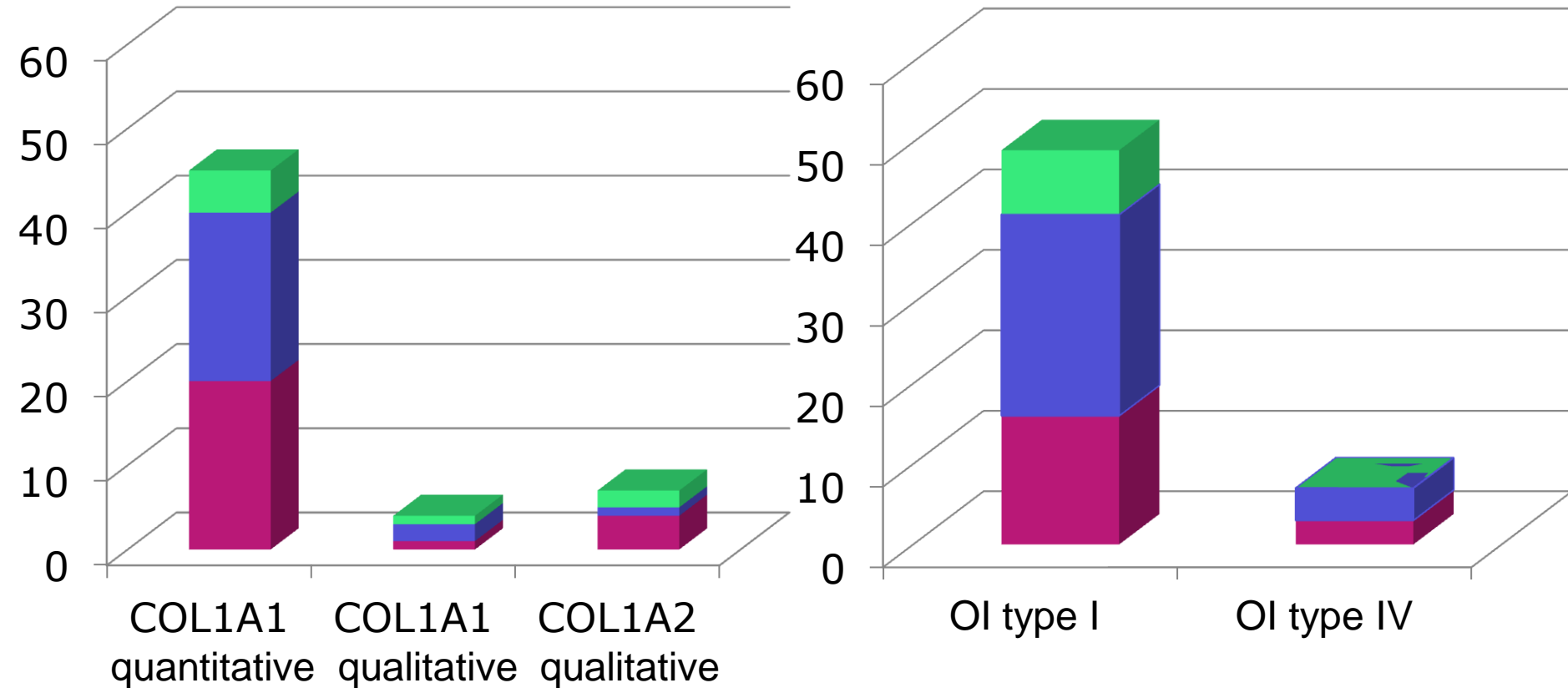
## Audiological phenotype



### III. Results

## Hearing loss as a function of OI type and genotype in 56 OI patients

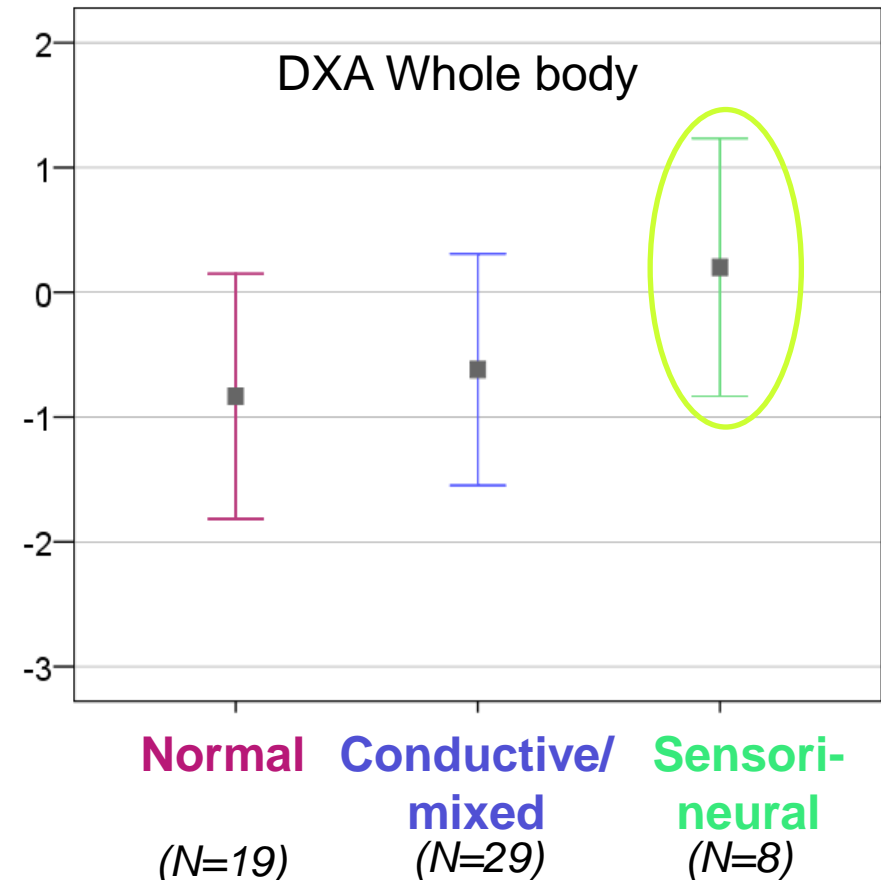
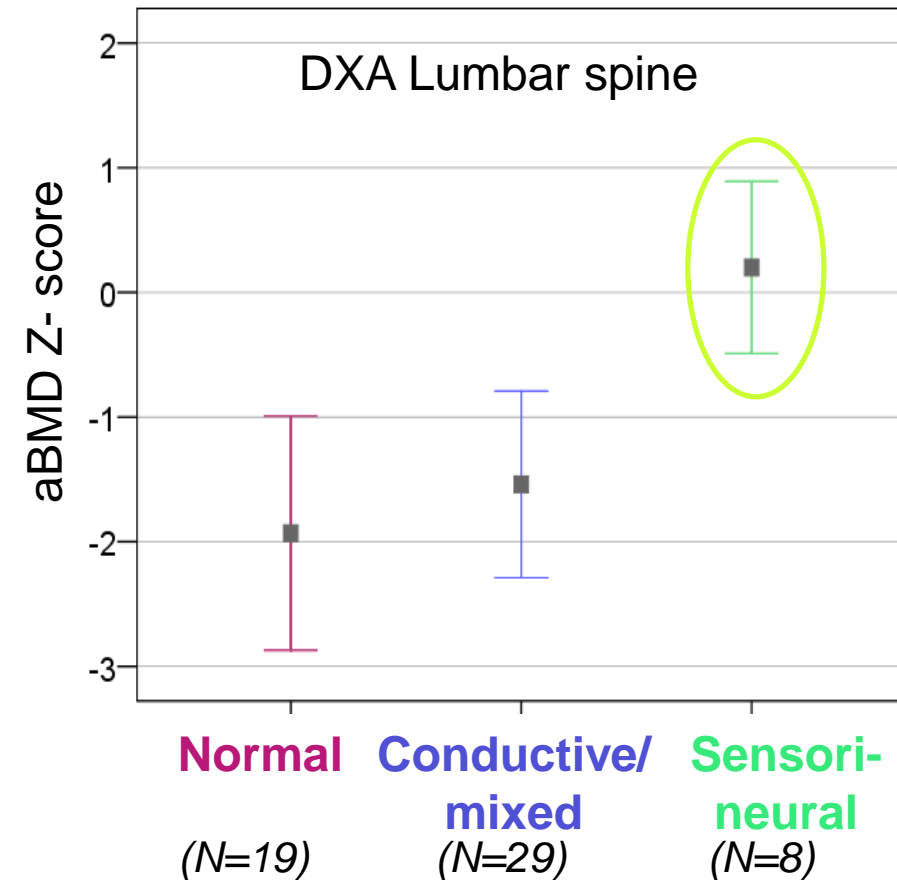
■ sensorineural    ■ conductive/mixed    ■ normal



**No association between hearing loss and mutated gene, type I collagen defect or OI type**

### III. Results

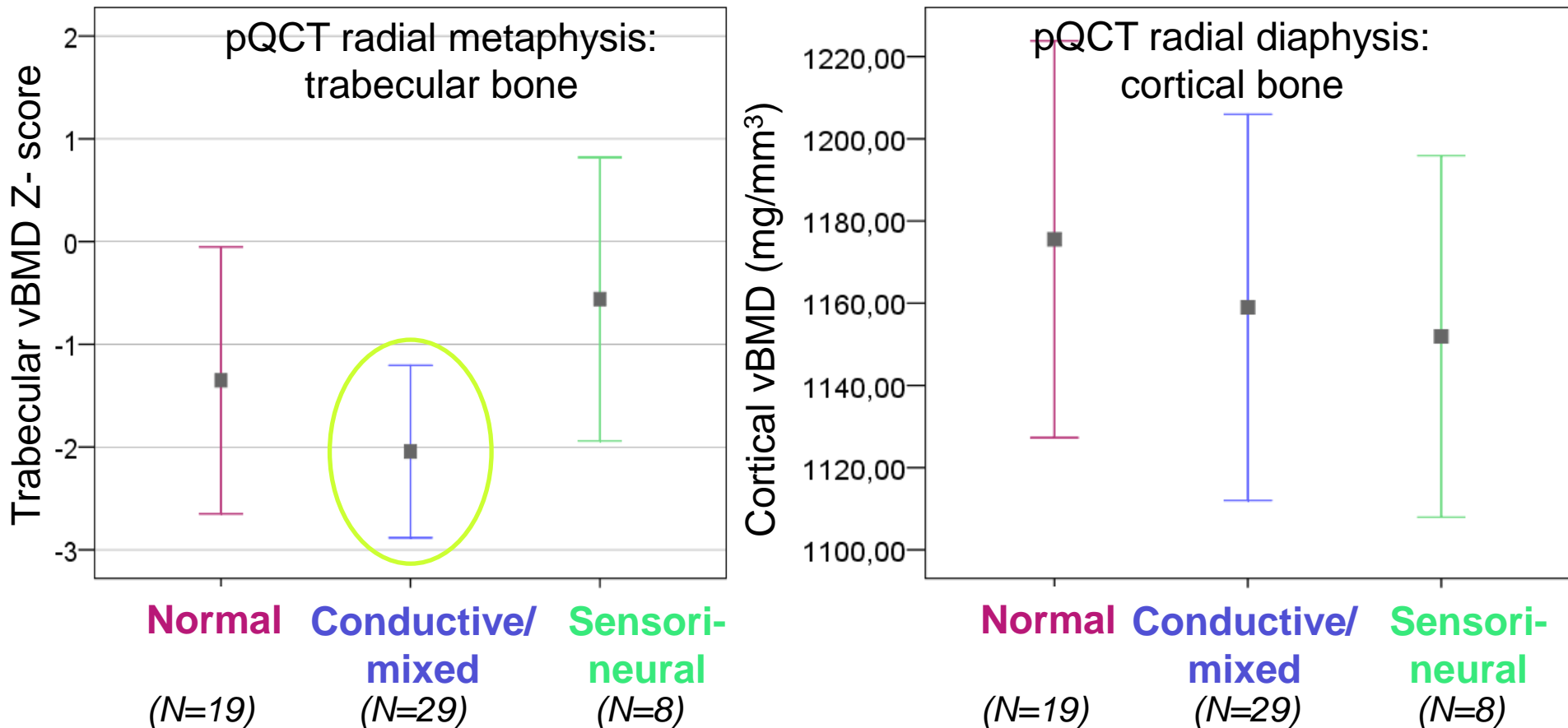
## Hearing loss as a function of aBMD (DXA)



- ☐ Mean z-scores < 0 (except sensorineural losses)
- ☐ ANCOVA [gender, weight, type I collagen defect] :  
sensorineural hearing loss > conductive/mixed hearing loss and normal hearing (P<0.05)

### III. Results

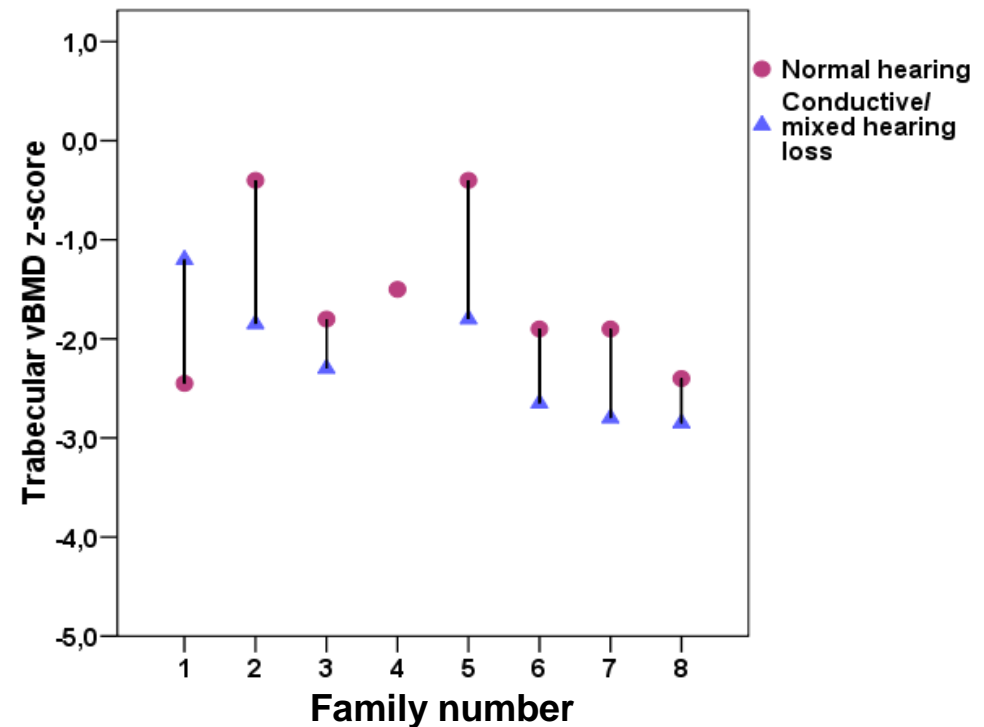
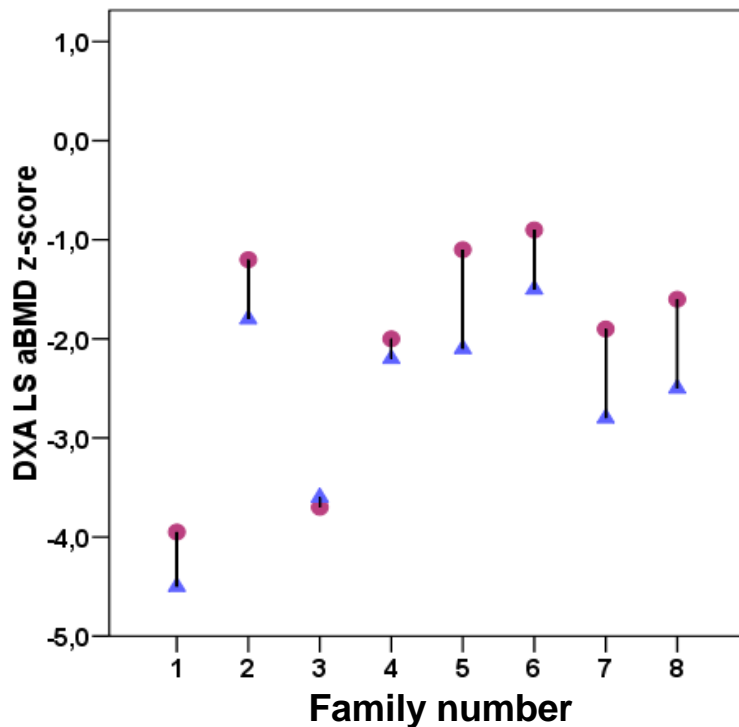
## Hearing loss as a function of vBMD (pQCT)



- ❑ ANCOVA<sub>[gender, age, type I collagen defect]</sub> for (trabecular vBMD z-score \*hearing):  
conductive/mixed hearing loss < normal and sensorineural hearing loss
- ❑ Radial diaphysis: no differences in cortical vBMD or bone geometry parameters

### III. Results

## Between-relatives comparisons of BMD and hearing



**OI patients with conductive/mixed hearing loss have lower BMD compared to their normal hearing relatives with OI**

## IV. Discussion

- ❑ OI patients with **conductive/mixed** hearing loss have **lower** BMD than patients with normal hearing or pure sensorineural loss
  
- ❑ OI patients with **pure sensorineural hearing** loss have **higher** aBMD than patients with normal hearing or conductive/mixed hearing loss (small sample + highest mean age)
  
- ❑ No differences in volumetric cortical bone mineral density or bone geometry parameters measured at radial diaphysis:
  - ! Cortical vBMD: unreliable parameter when cortical thickness < 2.0 mm (spatial resolution too low)

## V. Discussion

- ❑ Temporal bone:
  - Cortical bone
  - Bone formation complete at age 1 year
  - Bone remodeling is minimal
  
- ❑ Association conductive/mixed hearing loss and lower BMD: accumulating microfractures and fatigue microdamage destruct the osteoprotegerin (OPG) pathways which regulate temporal bone remodeling inhibition ?
  
- ❑ Future perspectives:
  - Replication in large population
  - Histological investigations of OI temporal bones
  - Effects of bisphosphonates on hearing in OI

