

# Aspects of bone quality and risk assessments in fracture and elective orthopaedic patients

## Akademisk avhandling

Som för avläggande av medicine doktorexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentlig försvaras i R-aulan, R-huset Mölndals sjukhus, Göteborgsvägen 31, Mölndal  
Fredag den 8 oktober klockan 09.00

av

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Avhandlingen baseras på följande delarbeten

- I. Bergh C, Wennergren D, Möller M, Brisby H. Fracture incidence in adults in relation to age and gender: A study of 27,169 fractures in the Swedish Fracture Register in a well-defined catchment area. *PLoS One*. 2020 Dec 21;15(12): e0244291. doi: 10.1371/journal.pone.0244291.
- II. Bergh C, Söderpalm A-C, Brisby H. Preoperative dual-energy X-Ray absorptiometry and FRAX in patients with lumbar spinal stenosis. *J Orthop Surg Res*. 2018;13:253. doi: 10.1186/s13018-018-0964-1 .
- III. Bergh C, Ekelund J, Möller M, Brisby H. 30-day and 1-year mortality after skeletal fractures: a register study of 295,713 fractures at different locations. *Acta Orthop*. 2021 Jul 26;1-7. doi: 10.1080/17453674.2021.1959003. Online ahead of print.
- IV. Bergh C, Ekelund J, Möller M, Brisby H. Mortality in relation to age after sustaining different skeletal fractures. *In manuscript*.

**SAHLGRENKA AKADEMIN  
INSTITUTIONEN FÖR KLINISKA VETENSKAPER**



# Aspects of bone quality and risk assessments in fracture and elective orthopaedic patients

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## Abstract

**Background:** Bone quality, bone strength, and bone remodelling are important in many orthopaedic conditions and can have an impact on fracture incidence, bone healing, implant failure, and different outcome aspects. There is relatively sparse information on fracture incidence and mortality both for all fractures compiled and for some of the individual fracture locations. In elective orthopaedic surgery, systematic screening for bone quality is rarely performed today.

**Aim:** The aim of the constituent studies of this thesis was to investigate epidemiology and mortality in patients sustaining different types of fractures in relation to age and gender and, furthermore, to investigate preoperative bone quality in a group of elective orthopaedic patients.

**Methods:** In studies I, III, and IV, data collected in the Swedish Fracture Register (SFR) were combined with data from Statistics Sweden (SCB) and the Swedish Tax Agency population register to calculate incidence and mortality for all fractures. The SFR data were divided into 27 anatomical locations. Incidence curves based on age and gender were calculated and grouped based on visual appearance (Study I). The standardized mortality ratio (SMR) was calculated for 30-day and 1-year mortality as the ratio between observed and expected mortality, (Studies III and IV). In study I, the catchment area was Gothenburg and surrounding municipalities, included 23,917 individuals sustaining 27,169 fractures during the 2015–2018 period. Studies III and IV included data on 295,713 fractures registered during the 2012–2018 period throughout Sweden. In study II, 65 patients undergoing elective surgery for lumbar spinal stenosis (LSS) and 53 patients with hip osteoarthritis (HOA) undergoing hip arthroplasty all underwent dual-energy X-ray absorptiometry (DXA) measurement of the femoral neck (FN) and in three projections/areas of the lumbar spine before surgery. The LSS patients also filled out the Fracture Risk Assessment Tool (FRAX) questionnaire and the results were compared with those of the DXA investigations.

**Results:** The fracture incidence was found to be 1229 fractures/10<sup>5</sup> person year, with the highest incidences for the wrist (201/10<sup>5</sup>), proximal femur (181/10<sup>5</sup>), ankle (127/10<sup>5</sup>), proximal humerus (101/10<sup>5</sup>), and metacarpals (89/10<sup>5</sup>) (Study I). Women sustained 64.5% of the fractures, 9.2% of which were registered as high-energy trauma and 2.3% as open fractures. Seven fracture incidence distribution groups were created (Study I). DXA measurements in LSS patients demonstrated large variations in BMD in the different projection with the lowest values for lateral projection of the vertebrae. No major differences regarding BMD were seen between the two elective patient groups (spine and hip patients). With DXA measurement of the lateral spine 71% of the spinal stenosis patients had less than -2.5 in T-score, while the FRAX questionnaire identified only 40% of these patients as high-risk patients. (Study II). The overall SMR at 30 days was found to be 6.8 (95% CI 6.7–7.0) and at one year 2.2 (95% CI 2.2–2.2) (study III). For 19/27 and 13/27 of the fracture locations at the two time points, respectively, the SMR was >2. Humerus, femur, and tibial diaphysis fractures were all associated with high SMR at both time points. For the oldest age group, 22 out of 27 fracture locations had an SMR ≥2 at 30 days (Study IV). Fractures of the femur (i.e., proximal, diaphysis, and distal) and humerus diaphysis were among the fractures associated with the highest mortality rates and SMRs within each age group.

**Conclusions:** Overall fracture incidence varied markedly with age and gender in different locations. The incidence curves suggested that proximal tibia fractures and ankle fractures in women, in addition to established osteoporosis-related fractures, are mainly osteoporosis related. Osteoporosis/osteopenia was common in the elective spine surgery patients, however and FRAX evaluation could not replace DXA measurement of the spine. Regardless of age, any type of femur fractures and humerus diaphysis fractures were associated with increased mortality. The high mortality rates seen for elderly patients with axial skeletal and proximal extremity fractures, indicate frailty in these patient groups.

**Keywords:** Fracture, Fracture incidence, Epidemiology, Mortality, Osteoporosis, Frailty, Spinal stenosis, Bone quality, Bone mineral density