Effect of egg production on bone quality in laying hens

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Introduction Laying hens show a very high prevalence of keel bone fractures in all housing systems, reaching up to 97 % of hens near the end of a production cycle. It is likely that affected hens suffer pain. Hence, bone fractures are one of the most serious animal welfare problems in the egg production industry. Since a lot of energy, protein and calcium is required for egg formation, high egg production might be one factor leading to metabolic stress contributing to this multifactorial problem.

Material and Methods The aim of this study was to investigate how egg production affects keel bone health and characteristics of long bones. A total of 76 laying hens of a pure-bred layer line (WLA) with an average laying performance of 320 eggs per year were kept in a group floor housing system from hatch until 62 weeks of age. 38 hens were given a Suprelorin® implant with the active component deslorelin acetate that suppressed follicle maturation and, thus, prevent egg production for three months. Subcutaneous implants were renewed every three months to cover the whole production cycle (group S). The other 38 hens were kept as control hens (group C). To detect keel bone fractures, all hens were radiographed monthly. In the 62nd week of age, hens were euthanized and dissected. Formaldehyde-fixed, paraffin embedded specimen from keel bones and tibiotarsi of selected hens were used for histopathology and morphometric analysis. Strength and chemical composition of tibiotarsi were analyzed using the following methods: three-point bending test, thermogravimetric analysis, infrared spectroscopy, X-ray diffraction and scanning electron microscopy.

Results Hens of group S showed significantly fewer keel bone fractures from the 32nd week of age onwards (group S: 1.64 %; group C: 67.46 %; $p<0.001$). Tibiotarsi of group S had a significantly larger diameter ($p<0.05$) and were mechanically stronger ($p<0.001$) compared to group C. Histopathology of selected keel bones from hens with and without fractures revealed that all hens displayed a variable degree of osteopenia of cortical and trabecular bone despite obvious medullary bone formation. In contrast, a much thicker cortical and trabecular bone consisting mainly of mature lamellar bone and no medullary bone was present in group S. Accordingly, morphometric assessment of tibiotarsal cross sections revealed a decreased relative cortex area in group C as compared to group S. The degree of mineralization of cortical bone was significantly lower in group S hens compared to group C hens ($p<0.05$). Medullary bone was present in tibiotarsi of group C but not of group S hens.

Conclusions These results give strong evidence that egg production plays an important role in the etiology of keel bone fractures. This is consistent with the differences in long bone characteristics that have been found: bone diameter and bone strength seem to be negatively influenced by egg production. The negative contribution to bone breaking strength of a smaller bone diameter cannot be compensated by the higher degree of mineralization of cortical bone and the presence of medullary bone in productive laying hens.