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Keel bone fractures in laying hens –
Effects on individual productivity and mobility

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SUMMARY

Impaired skeletal health manifesting in keel bone fractures is one of the greatest welfare problems in commercial laying hens, with reports of up to 97 % of hens within a flock having some level of damage. Keel bone fractures are assumed to be a consequence of the selection for high productivity, and it is believed that the housing environment relates to both the susceptibility for and the actual occurrence of fractures. Existing studies investigating the effect of keel bone fractures on laying hen behaviour, pain or productivity could not provide consistent results and conclusions regarding welfare implications of keel bone fractures. The aim of the present thesis was to provide a superior approach to evaluate keel bone fractures longitudinally and to investigate the individual productivity and mobility in response to fractures in individual hens housed in large groups under commercially relevant conditions. We hypothesized that hens with keel bone fractures would produce fewer eggs of lower quality than hens with healthy keels, and that mobility of hens would be impaired in hens having fractures.

One methodological issue of existing studies is the lack of accuracy and reliability of currently used methods for keel bone fracture assessment such as palpation or dissection. In contrast, radiographic imaging allows longitudinal observations and provides detailed information for individual fractures, but no standardized system exists to assess fracture severity from radiographs if multiple fractures are present. We therefore developed a scoring system based on a tagged visual analogue scale, ranging from ”no fracture” to “extremely severe”, and created an online tutorial to train observers for scoring (Chapter II). As we found high inter- and intra-observer reliability indicating excellent agreement and similar ratings across and within participants, we applied this method for fracture assessment in the subsequent studies.

In order to investigate the effect of keel bone fractures on individual productivity, we measured egg laying performance and egg quality of individual hens throughout the entire laying cycle (Chapter III). Radiographs were performed after each data collection to score keel bone fracture severity and to assess the healing activity of each keel. Both keel bone fracture severity and healing activity were linked to reduced egg laying performance, but the responses varied across age. Hens were able to maintain high performance irrespective of keel bone fracture severity until shortly after peak of lay, but the negative effect of keel bone fracture severity on individual production was amplified at the end of lay suggesting that hens were no longer able to cope with the physiological challenge of a fracture. Egg quality was not related to fractures. The dramatic decrease in performance at the end of lay in hens with severe keel bone fractures not only raises potential economic concerns for producers but also implies reduced fitness and consequent welfare problems in laying hens suffering from keel bone fractures.

To study how keel bone fractures affect the mobility of individual hens in aviary systems, we investigated the movements of individual hens between five zones of the aviary (litter, lower tier, nest boxes, top tier, and wintergarden) using a custom-made infrared tracking system (Chapter IV). Again, hens were observed throughout the entire laying cycle and radiographs were performed to score fracture severity. We found an association between keel bone fractures and the location of staying within distinct zones of the aviary but could not confirm our prediction that keel bone fractures would reduce the transitions between zones. Our findings indicate that hens with keel bone fractures were still moving within the aviary but remained within the upper tiers (i.e., mostly between nest box zone and top tier) rather than the mid and lower areas (i.e., between litter, lower tier and nest box zone).

In summary, we reported that keel bone fracture severity was associated with a decrease in egg laying performance but did not affect egg quality. Overall movement within the aviary was not affected in response to keel bone fractures though substantial changes in location were associated with keel bone fracture severity. We conclude that keel bone fractures were associated with impaired fitness of laying hens and affected species-typical behaviour. This thesis contributed to the current body of knowledge by providing information about the effect of keel bone fractures on individual productivity and mobility, whereas results were obtained from individual hens kept under commercially relevant conditions. Further research is needed to draw conclusions on keel bone fractures as a multifactorial welfare issue and to provide practical solutions for producers to reduce fracture prevalence.