Experimental study of the interaction between *Salmonella enterica* serovar Typhimurium and *Oesophagostomum* spp.

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Summary: The aim of this study has been to investigate the possible interaction between infections with *Salmonella enterica* serovar Typhimurium (S. Typhimurium) and *Oesophagostomum* spp. In an experimental set-up, groups of 10 pigs were infected with A) a mixture of *O. dentatum* and *O. quadrirspinulatum*; B) *O. dentatum*, *O. quadrirspinulatum* and *S. Typhimurium*, and C) *S. Typhimurium* only. Our study suggests that *Oesophagostomum* spp. infection in pigs provides the basis for a prolonged and intensified *S. Typhimurium* infection. Both levels and number of *S. Typhimurium* excreting pigs per day were significantly higher in the group with both *Oesophagostomum* spp. and *S. Typhimurium* infection compared to the group infected with *S. Typhimurium* only. Post mortem examinations paralleled these findings and demonstrated higher occurrence of *S. Typhimurium* in pigs with concurrent parasite infection compared to pigs infected with *S. Typhimurium* only. An effect of the *S. Typhimurium* infection on the *Oesophagostomum* infection was not observed.

Keywords: pathogenesis, double infection, subclinical infection, helminths, synergy

Introduction: Infection with gastrointestinal helminths in pigs rarely causes clinical disease, but mainly results in production losses due to decreased feed conversion ratio. We hypothesise that gastrointestinal helminths such as e.g. *Oesophagostomum* spp., which is relatively prevalent in the Danish pig production (Roepstorff and Jorsal, 1989), may facilitate invasion and persistence of *Salmonella*. As part of the life cycle of *Oesophagostomum* spp., the larvae penetrate the mucosa of the proximal part of colon to become encysted, causing nodule formation, inflammation, haemorrhages and ulcers (Stockdale, 1970). Thus, a concurrent infection with *Oesophagostomum* spp. might promote invasion of the mucosa and subsequent persistence of *S. Typhimurium* in the mucosa and lymphoid tissue of the gut.
Material and Methods: Three groups of 10 pigs were infected with A) a mixture of *Oesophagostomum dentatum* and *O. quadrispinulatum*; B) *O. dentatum, O. quadrispinulatum* and *S. Typhimurium*, and C) *S. Typhimurium* only. Pigs in groups A and B were trickle infected with *Oesophagostomum* spp. three times weekly throughout the experiment. After 19 days, groups B and C were challenged orally once with approx. $1.8 \times 10^7$ c.f.u. *S. Typhimurium*. One pig from each group was euthanised on the day of salmonella challenge, and 2 and 4 days post salmonella challenge (psc). The remaining pigs were euthanised on days 16 and 17. Faecal samples collected before challenge together with tissue samples and intestinal contents *post mortem* were examined bacteriologically by qualitative assessment as described by Baggesen et al. (1999). Following challenge, the excretion level of *S. Typhimurium* was examined by semi-quantitative assessment as described (Baggesen et al., 1999). Counts of helminth eggs were performed by a concentration McMarster technique (Roepestraff and Nansen, 1998). After euthanasia the animals were immediately subjected to *post mortem* examination. Samples were collected for histological examination and for immunohistochemical detection of *S. Typhimurium* (Pospichil et al., 1990).

Results and Conclusion: No clinical signs of salmonellosis were observed among the salmonella infected pig whereas pigs infected with *Oesophagostomum* had intermittent diarrhea from two days post challenge throughout the study period. Salmonella was not detected previous to challenge and there was no indication of cross-contamination of either Salmonella or helminths between experimental groups. Examination of faecal excretion levels of *S. Typhimurium* revealed that pigs concurrently infected with *Oesophagostomum* spp. excreted a significantly higher amount of *S. Typhimurium* than helminth free pigs ($P=0.05$) (*Figure 1*). On three single days (days 5, 8 and 17) group B was excreting significantly higher levels of *S. Typhimurium* (*Figure 1*). Pigs with worms also had significantly more positive *S. Typhimurium* excreting days per animal, with a mean of 5.6 positive animals per day in group B and 3.1 per day in group C ($P=0.036$). After 16 days of *S. Typhimurium* infection the pigs infected with worms excreted up to 2000 CFU per gram faeces with a mean excretion in the *Oesophagostomum* spp. infected group of approximately 700 compared to a mean of 3.5 CFU in the group without worms.
Figure 1. Mean recovery and standard deviation of Salmonella Typhimurium in faecal samples from pigs challenged with S. Typhimurium and Oesophagostomum spp. (group B, n=7) and pigs challenged with S. Typhimurium only (group C, n=7). * p < 0.05, ** p < 0.005

[S. Typhimurium was detected both in the caecum and colon in the majority of pigs with worms, whereas in the majority of pigs without worms S. Typhimurium was only detected in the colon. S. Typhimurium was detected immunohistochemically in seven out of 9 pigs with worms and only in two out of 9 pigs without. S. Typhimurium did not appear to influence worm burdens. The results suggest that Oesophagostomum spp. infection in pigs provides the basis for a prolonged and intensified S. Typhimurium infection, which may have significance in relation to control of the infection.

References: