Sertoli cell tumour in a neonate calf: an unusual congenital tumour

A case report

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Keywords

Neonate, Sertoli cell tumour, immunophenotype, zearalenone, deoxynivalenol

Summary

Congenital testicular tumours are seldom reported in bovine species. This case report describes the clinical, sonographical, haematological, pathomorphological and immunohistological features of a Sertoli cell tumour in a neonatal German Holstein calf. Microscopically, the enlarged testicle was composed of neoplastic cells, which were packed in well-formed tubules. The mostly polygonal shaped cells had round to elongated nuclei and a scanty eosinophilic cytoplasm. Some cells were arranged perpendicularly to the light PAS-positive basement membrane. These cells were packed in broad sheets separated by dense fibrous stroma. Mitotic figures were present. The features described above are indicative of a Sertoli cell tumour. The contralateral testicle showed a well formed rete testis, fusiform cells and a dense central capillary convolute and haemorrhagic foci. The features are indicative of an extensive fibrosis and older haemorrhage. The neoplasia was immunopositive for vimentin, α-oestrogen receptor, α-inhibin and S-100 protein, but immunonegative for cytokeratine, CD30, progesterone receptor, α-fetoprotein, SALL4, OCT4 and glypican-3. The mycotoxicological investigations revealed the presence of residues of zearalenone, deoxynivalenol, ochratoxin, HT2 toxin and their metabolites in feeds and urine of heavily pregnant cows of the herd. Furthermore, information is provided about oestrogen and testosterone levels of the affected and healthy neonatal calves. A possible influence of mycotoxins on the cancerogenesis is discussed.

Schlüsselwörter

Neonat, Sertoli-Zell-Tumor, Immunphänotyp, Zearalenon, Deoxynivalenol

Zusammenfassung

Berichte über kongenitale Hodentumore bei Rindern sind selten. Der Fallbericht beschreibt die klinischen, sonographischen, hämatologischen, pathomorphologischen und immuhistologischen Merkmale eines Sertoli-Zell-Tumor bei einem neugeborenen Deutsche-Holstein-Kalb. Histologisch wies der vergrößerte Hoden bindegewebig eingeteilte intratubuläre polygonale Tumorzellen mit runden bis fusiformen Kernen und leicht eosinophilem Zytoplasma auf. Einige Tumorzellen standen senkrecht zur Basalmembran. Die Tumorzellplatten waren durch ein fibröses Stroma septiert. Mitosen waren nachweisbar. Die genannten Merkmale sprechen für einen Sertoli-Zell-Tumor. Der kontralaterale Hoden zeigte ein gut ausgebildetes Rete testis, teils unreife fusiforme Zellen, zentral ein dichtes Gefäßkonvolut sowie fokale Einblutungen. Dies spricht für eine ausgedehnte Fibrose und ältere Einblutungen. Die Neoplasie war immunpositiv für Vimentin, α-Östrogen-Rezeptor, α-Inhibin und S-100 Protein, aber immunnegativ für Zytokeratin, CD30, Progesteronrezeptor, α-Fetoprotein, SALL4, OCT4 und Glypican-3. Mittels mykotoxikologischer Untersuchung konnten Zearalenon, Deoxynivalenol, Ochratoxin, HT2-Toxin bzw. deren Metaboliten in Futter- und Harnproben der hochtragenden Kühe der Herde nachgewiesen werden. Darüber hinaus wurden Informationen über den Östrogen- und Testosteronspiegel bei dem erkrankten Neonaten sowie bei neugeborenen gesunden Vergleichskälbern gewonnen. Eine mögliche Rolle der Mykotoxine in der Kanzerogenese wird diskutiert.

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Introduction

Gonadal tumours are frequently found in older male animals, particularly in dogs, less frequent in horses, but rare in other species. The last group of animals are neutered generally early or, in the case of farm animals, slaughtered. This could be the main reason why testicular tumours are very rare in bovine, porcine, ovine, caprine and feline species. The testis is the third most common site of neoplasia in male dogs, exceeded only by tumours of the skin and connective tissue. The occurrence of bovine congenital tumours (yolk sack tumour, Sertoli cell tumour, seminoma) has been reported (4, 21, 27), but no report has yet attempted to integrate the environmental factors such as mycotoxins, hormones or radioactivity in the investigations. The present study describes a rare case of a Sertoli cell tumour in a neonatal calf. We report the results of the clinical, sonographical, haematological, pathomorphological, immunohistological, mycotoxicological, endocrinological and serological investigations. Furthermore, the ambient radioactivity prevailing around the stable was recorded.

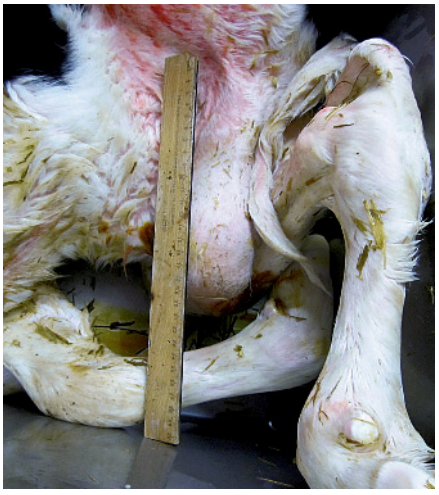

Fig. 1 Enlarged right testicle within the scrotum of the calf at birth.

Abb. 1 Vergrößerter rechter Hoden im Hodensack des Kalbes bei der Geburt

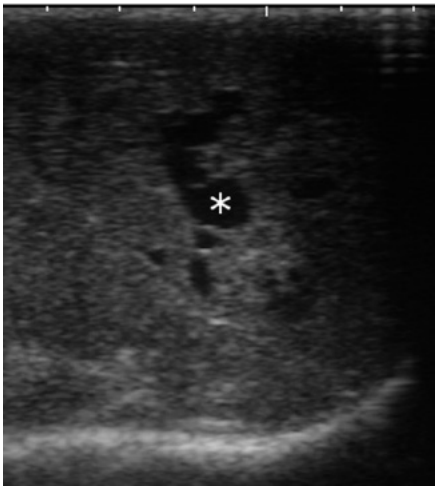

Fig. 2 Transverse ultrasonographic scan (6.5 MHz linear transducer): distinct hypoechogenic cavernous structure in the centre of the enlarged testicle (asterisk).

Abb. 2 Ultrasonographischer Transversalschnitt (6,5-MHz-Linearschallkopf): deutliche hypoechogene kavernöse Struktur im Zentrum des vergrößerten Hodens (Stern)

Case report

History and examinations

A male calf was born on term on the 28th January 2015 in a shed with 1850 German Holstein dairy cows and presented to the herd veterinarian. The clinical examination of the neonate revealed ad initio an enlarged right testicle in the scrotum. The left testicle was palpable subcutaneously in an inguinal position and was estimated as age-related normal sized. A sonographic examination of the testicles was performed using an ultrasound device (Proxima Pavo Pro, Proxima Medical Systems GmbH, Weil am Rhein/D) equipped with a 6.5 MHz linear transducer.

Blood samples from the jugular vein (EDTA blood and serum; Kabevette, Kabe Labortechnik GmbH, Nümbrecht-Elsenroth/D) were taken from the calf and its mother within 24 hours after birth for haematological and serological investigations, respectively. On the third day of life, both testicles were removed surgically. However, the calf died 4 days later due to neonatal diarrhoea, despite of the application of a standard therapy. The recommendation for a full autopsy was refused by the farmer for reasons of costs. For histology, tissue samples were taken from both the enlarged and the retained testis, and fixed in 10% buffered formalin.

Samples of both testicles were processed routinely and stained with H&E and PAS. In order to specify the immunophenotype of the specimens, the following antibodies were used according to Yu et al. (37) and Dabbs (8): vimentin, cytokeratine, CD30, α-oestrogen receptor (ERα), progesterone receptor (PR), α-fetoprotein, α-inhibin, SALL4 (sal-like protein 4), OCT4 (octamer binding transcription factor 4), glypican-3 and S-100 protein. For the immunohistochemistry, the paraffin fixed tissues were treated routinely (35). A canine Sertoli cell tumour was used as a positive control. Negative controls were obtained by omitting the primary antibodies.

Furthermore, feed samples (total mixed ration for dry cows during the last month of pregnancy, containing grass silage, corn silage, straw, bruised grain, and minerals as well as grain of corn) were collected. Urine samples were taken from six pregnant cows one week before the expected calving date, pooled, and stored at –80 °C. The mycotoxicological investigations of feed samples, blood samples of the calf and urine samples of the cows were performed by HPLC-MS/MS (1). The serum testosterone and oestrogen concentrations of the neonate were analysed using a direct enzyme-immunoassay (EIA) according to Meyer et al. (26) and Prakash et al. (31). Due to the lack of reference ranges, six healthy controls (three female and three male calves, respectively) were included in the investigations. These cohort calves were born within the same week

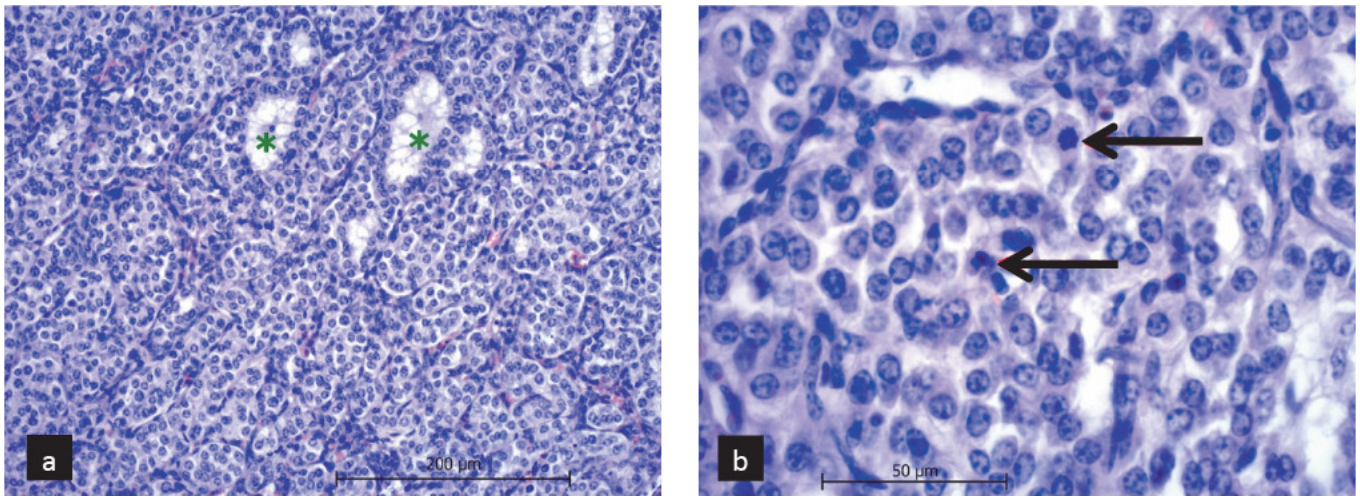

Fig. 3 Sertoli cell tumour. a) Well formed intratubular polygonal tumour cells with eosinophilic cytoplasm and scanty eosinophilic material in the central glades (asterisks). b) Diffuse neoplastic cell tumours with mitotic figures (arrows). H&E stain.

Abb. 3 Sertoli-Zell-Tumor. a) Gut geformte intratubuläre polygonale Tumorzellen mit eosinophilem Zytoplasma und schwach eosinophilem Material in den Lichtungen (Sterne). b) Diffuse neoplastische Tumorzellen mit mitotischen Figuren (Pfeile). HE-Färbung.

as the affected neonate on the farm. Serum samples were taken within 24 hours after birth.

Results

Clinical and sonographic findings

The scrotum of the neonate was 21 cm long and had a maximum circumference of 42 cm (▶Fig. 1). The ultrasonographic investigation revealed a normal homogenous parenchyma only in the proximal and distal area of the enlarged right testicle, whereas an irregular-shaped tissue and hypoechogenic cavernous structures were found in the central part (▶Fig. 2).

Morphological findings

The right testicle weighed 327.0 g and measured 13.0 x 9.0 x 8.0 cm, while the left testicel weighed only 7 g and had a dimension of 4.5 x 3.5 x 1.0 cm. The head and tail of the attached epididymis were undersized in relation to the testicle.

The macroscopic examination on the cut surface of the right testicle showed reddish-brown, greasy tissue structures separated by septa throughout the entire organ. In the centre, a small amount of a gelatinous substance was present. The left testicle revealed a homogenous, gray-whitish tissue structure.

Histologically, the right testicle showed an intact tunica albuginea with adjacent atypic cell proliferation. These cells were lobular packed in well-formed tubules with a central glade (▶Fig. 3a). The mostly polygonal shaped cells had round to elongated nuclei and a scanty eosinophilic cytoplasm. Some cells were arranged perpendicular to the light PAS-positive basement membrane. Areas with irregular shaped cells were also noted. These cells were packed in broad sheets separated by dense fibrous stroma. Mitotic figures were present (▶Fig. 3b). The features described above fit to a Sertoli cell tumour. Multifocal mononuclear infiltrates were also present.

The left testicle showed a well formed rete testis, fusiform cells and a dense central capillary convolute, whose wall appeared immature. A prominent haemorrhage was present. Scattered tubuli seminiferi-like formations without stages of spermatogenesis were present (▶Fig. 4). The features of this testicle correspond to an extensive fibrosis and haemorrhage.

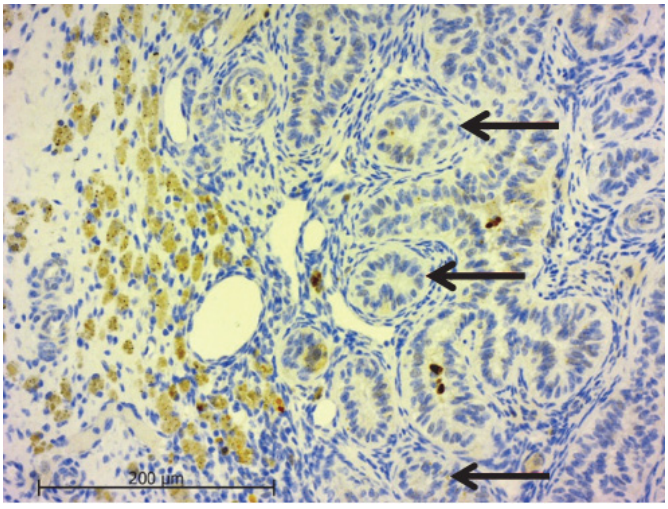

Fig. 4 Contralateral testis. Fusiform cells and scattered tubuli seminiferi like-formations without stages of spermatogenesis (arrows). Immunohistological intracytoplasmatic expression of S-100 protein.

Abb. 4 Kontralateraler Hoden. Fusiforme Zellen und einzelne Tubuli-seminiferi-ähnliche Gebilde ohne Entwicklungsstadien der Spermatogenese (Pfeile). Immunohistologische intrazytoplasmatische Expression von S-100-Protein.

Immunohistological findings

The tumour was strongly positive for S-100 protein, positive for ERα and weakly positive for α-inhibin and vimentin (▶Fig. 5). The tumour was immunonegative for cytokeratine, PR, α-fetoprotein, SALL4, OCT4, CD30 and glypican-3 (▶Table 1). Tissue of the inguinal located testicle was only weakly positive for vimentin and positive S-100 protein (▶Fig. 4), while the tissue was negative for cytokeratine, CD30, ERα, PR 10A, α-inhibin, SALL4, OCT4 and glypican-3 (▶Table 1).

Haematological, serological and mycotoxicological findings, hormone concentrations and radioactivity

The **haematological investigation** of an EDTA blood sample of the neonate taken on the first day of life revealed values for leukocyte count, erythrocyte count and thrombocyte count as well as total serum protein within the reference ranges according to Moritz et al. (28). However, in the white blood count the relative proportion of neutrophil granulocytes (78%; reference range: 25–45%) was elevated, while lymphocytes were reduced (9%; reference range: 45–65%). Prior to the histopathology, a detailed **serological analysis** of a serum sample of the dam concerning common protozoa, bacteria and viruses, i. e. *Neospora canium*, *Brucella* spp., *Leptospira* spp., *Coxiella burnetii*, *Chlamydia* spp., Schmallenberg virus, and bovine herpesvirus 1, was performed. No antibodies were detected (data not shown).

From the mixed feed and corn **feed**, the following **mycotoxins** were quantified: zearalenone (ZEA), deoxynivalenol (DON), ochratoxin A and T2/HT2 toxin. According to the recommendation of the European Commission from 17th August 2006 (17, 18),

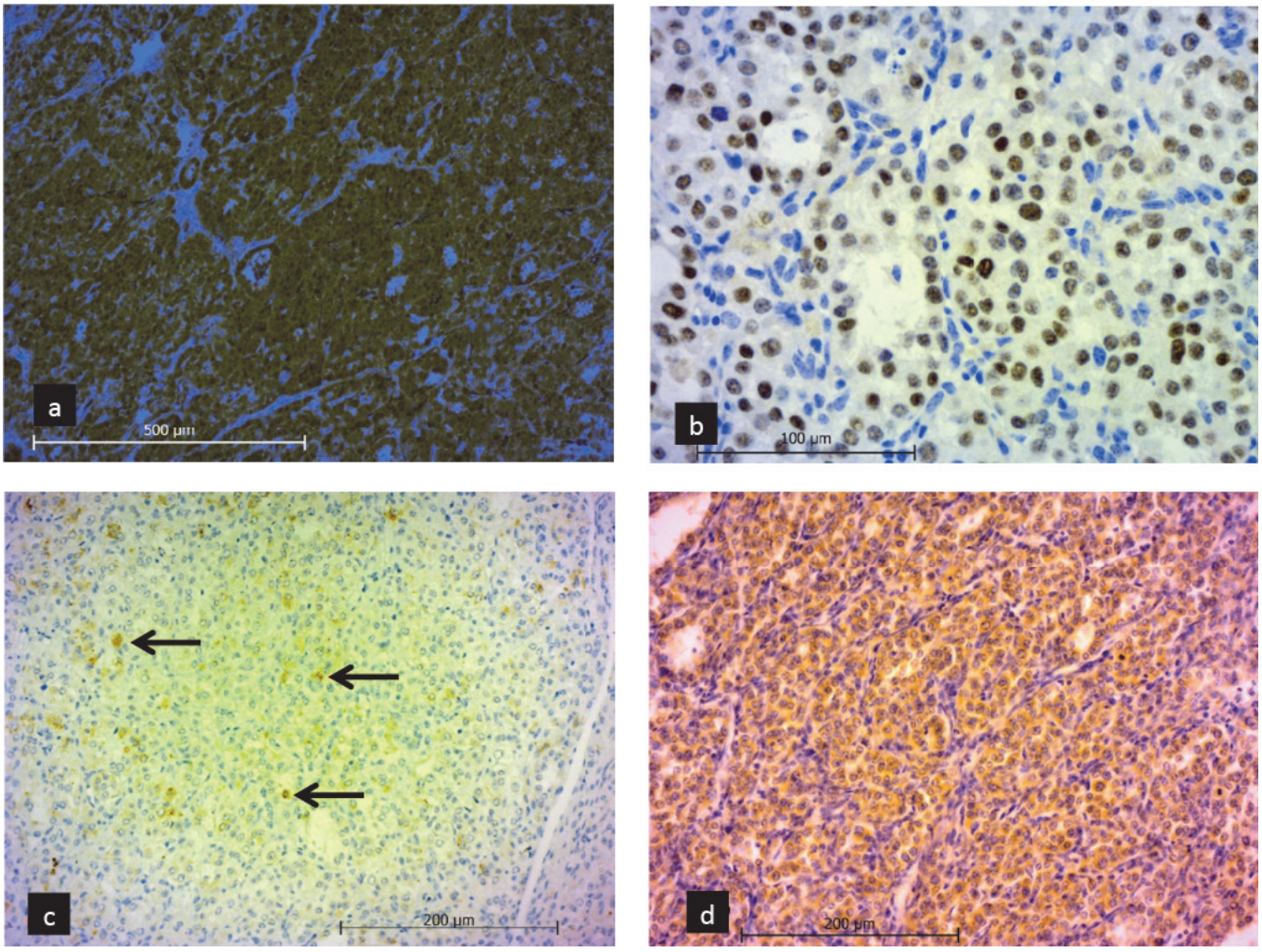

Fig. 5 Immunohistological antibody expression of the Sertoli cell tumor. a) Strongly positive intracytoplasmatic expression of S-100 protein. b) Positive intranuclear expression of ERα. c) Weakly intracytoplasmatic expression of α-inhibin (arrows). d) Weakly intracytoplasmatic expression of vimentin.

Abb. 5 Immunhistologische Antikörperexpression des Sertoli-Zell-Tumors. a) Starke intrazytoplasmatische Expression von S-100-Protein. b) Positive intranukleäre Expression von ERα. c) Schwache intrazytoplasmatische Expression von α-Inhibin (Pfeile). d) Schwache intrazytoplasmatische Expression von Vimentin.

Table 1
Immunoreactivity of the Sertoli cell tumour and the contralateral testicle.

Tab. 1
Immunhistologisches Reaktionsmuster des Sertoli-Zell-Tumors und des kontralateralen Hodens

Antibodies	Clons	Type of antibody	Dilution	Results	
				Sertoli cell tumour	Contralateral testicle
Vimentin	Vim3B4	monoclonal	1:50	+	+
Cytokeratine	MNF-116	monoclonal	1:50	–	–
CD30		monoclonal	1:200	–	–
α-oestrogen receptor	ERα	monoclonal	1:50	++	–
Progesterone receptor	PR 10A	monoclonal	1:50	–	–
α-fetoprotein		monoclonal	1:400	–	–
α-inhibin	R1	monoclonal	1:100	+	–
SALL4	SALL4	monoclonal	1:100	–	–
OCT4	OCT4	monoclonal	1:100	–	–
Glypican-3	Gly-3	monoclonal	1:100	–	–
S-100 protein		monoclonal	1:200	+++	++

– = negative; + = weakly positive; ++ = positive; +++ = strongly positive

none of the analysed mycotoxins was elevated in the mixed feed (▶Table 2).

The **mycotoxicological urine tests** included 14 mycotoxins and their metabolites, respectively. Nine substances were detectable by HPLC, whereas five were not (▶Table 3). Unfortunately, there are no reference values for these compounds in bovine urine samples.

The **serum** of the neonate was examined for ZEA, α-ZEN, β-ZEN, zearalanone (ZAN), α-ZAN, β-ZAN, DON, and de-epoxy-DON. None of these toxins or metabolites was detectable by HPLC.

The neonate under investigation as well as male and female controls, had > 140 pg/ml **oestrogen** in their serum, whereas the **testosterone** level varied between not detectable (< 0.02 ng/ml) in females and 0,08 ng/ml in male neonates. The neonate showed a level of 0.06 ng/ml (▶Table 4). Thus, descriptive differences were not recorded.

The German Federal Office for Radiation Protection in Salzgitter has a network of 80 monitoring stations in Saxony. The closest measuring point to the stable is at a distance of 15.0 km. The hourly recorded values of the last 12 months were evaluated. None of the values exceeded 0.12 µSv/h (18).

Discussion

In cases of scrotal enlargement in bovine species, several differential diagnoses such as scrotal hernia, scrotal haematoma, scrotal oedema, orchitis, epididymitis, and scrotal or testicular neoplasia have to be considered (4). In the present case, scrotal and epididymal alterations were excluded by clinical and sonographical investigations. Inflammation of the enlarged testicle was excluded by histopathological examination which revealed the proliferation of tumour cells.

According to the World Health Organisation (WHO) histological classification, there are three groups of testicular tumours: a) gonadostromal tumours with Leydig cell tumour and Sertoli cell tumour, b) germ cell tumours with seminoma, teratoma and embryonal carcinoma, and c) mixed germ cell-sex cord stromal tumours (22). They occur usually in middle-aged to old species (15, 24). Reports on congenital Sertoli cell tumours in calves are rare (6, 27, 29). Other studies reported on a Leydig cell tumour in a new-

Table 2 Mycotoxin content in mixed feed and corn feed for the cows (88% dry matter) fed in the last month of pregnancy.

Tab. 2 Mykotoxingehalt in Misch- und Maisfutter (88% Trockenmasse), das die Kühe im letzten Monat der Trächtigkeit erhielten

Mycotoxins	Total mixed feed (µg/kg)	Grain of corn feed (µg/kg)	Reference (14) Mixed ration/ grain (µg/kg)
Aflatoxin B1	n. d.	n. d.	< 10 / < 20
Zearalenone (ZEA)	210	600	< 500 / < 2000
Deoxynivalenol (DON)	2108	1892	< 5000 / < 8000
Ochratoxin A	43	30.4	< 50 / < 250
T2/HT2 toxin	70.5	36.9	– / < 500

T2/HT2 toxin = 15-Acetoxy-α,4β-dihydroxy-8α-(3-methylbutyryloxy)-12,13-epoxytrichothec-9-ene
n. d. = not detectable

Table 3 Mycotoxin content in a pooled urine sample (n = 6) of cows 1 week ante partum.

Tab. 3 Mykotoxingehalt einer gepoolten Urinprobe (n = 6) der Kühe 1 Woche ante partum

Mycotoxins	Concentration (ng/ml)
Deoxynivalenol	26.9
De-epoxy-deoxynivalenol (DOM-1)	916.0
3-acetyl-deoxynivalenol	12.5
15-acetyl-deoxynivalenol	10.6
Zearalenone	2.5
α-zearalenone	1.0
β-zearalenone	20.1
Zearalanone	1.1
α-zearalanol	1.0
β-zearalanol	n. d.
Aflatoxin B1	n. d.
Aflatoxin M1	n. d.
Ochratoxin	n. d.
T2/HT2 toxin	n. d.

T2/HT2 toxin = 15-Acetoxy-α,4β-dihydroxy-8α-(3-methylbutyryloxy)-12,13-epoxytrichothec-9-ene
n. d. = not detectable

Table 4 Oestrogen and testosterone level in serum samples of the neonate calf affected by a Sertoli cell tumour and six healthy neonate calves.

Tab. 4 Östrogen- und Testosterongehalt im Blutserum des Neonaten mit Sertoli-Zell-Tumor und sechs anderen gesunden neugeborenen Kälber

Number	Sex	Classification	Oestrogen (pg/ml)	Testosterone (ng/ml)
1	male	healthy	> 140.0	0.05
2	male	healthy	> 140.0	0.04
2	male	healthy	> 140.0	0.08
4	**male**	**Sertoli cell tumour**	**> 140.0**	**0.06**
5	female	healthy	> 140.0	0.02
6	female	healthy	> 140.0	< 0.02
7	female	healthy	> 140.0	< 0.02

born calf (23), or a yolk sac tumour in 28–55 days old calves (1, 23), and in a newborn calf (33), respectively. Except the last investigators, no study in calves has focused on the immunophenotype of the bovine tumours. The tumour in the present case was immunopositive for α-inhibin, S-100 protein, ERα and vimentin, whereas the other applied antibodies reacted negatively. The dimeric glycoprotein α-inhibin is specific for sex cord stromal tumours such as granulosa cells and Sertoli cell tumour in humans and canine species (8, 34, 35). In addition to the histology, the immunoreactivity of α-inhibin and vimentin are the most remarkable for canine Sertoli cell tumour (37). The latter antibody is a useful marker for distinguishing non-epithelial from epithelial derived neoplasms. The immunonegativity for OCT4, CD30, SALL4, α-fetoprotein and glypican-3 clearly distinguishes the Sertoli cell tumour from the main differential diagnoses such as seminoma, embryonal carcinoma, teratoma and testicular yolk sac tumour (7, 29, 32, 34). These tumours, but also choriocarcinoma and intratubular germ cell neoplasia, are usually positive for SALL4 and OCT4 (8). The present study confirms the investigations of Yu et al. (37), who supplementary used desmin, placental alkaline phosphatase (PLAP) and c-KIT within the framework of a comparative study of canine testicular tumours. The antigen SALL4 (sal-like protein 4) is a zinc finger transcription factor and homologous to the Drosophila spalt (sal) gene. It is a novel stem cell marker essential to maintain pluripotency and self-renewal of embryonic stem cells (5). Empirical data on this antigen is not available in veterinary pathology, except in mice and monkeys (11). The immunonegativity for α-fetoprotein, and the positivity for α-inhibin distinguish the tumour in the present case clearly from a testicular yolk sac tumour (8, 32).

In the pediatric pathology, Sertoli cell tumours are also uncommon. The neoplasm constitutes only 2–3% of the primary testicular tumours in children (20). Similar veterinary statistics are fraught with problems, especially in livestock. Presumably, not all cases of testicular enlargement are presented to the veterinarian and pathologist, which potentially lead to an underestimation of the incidence of testicular tumours.

In conclusion, with regard to the relevance of ZEA and DON, it needs to be emphasised that the diet concentrations of ZEA and DON may be discussed as being pathogenetically important though they did not exceed the EC guidance values for critical diet concentrations. Recently it was shown that both toxins and some of their metabolites are dose-dependently transferred to bovine follicular fluid and to porcine foetuses (2, 9, 10). Although placentation differs between sows and cows, a placental transfer and possible adverse effects on the foetus during chronic latent increased exposure of the pregnant cow cannot be excluded. Using exposure estimation equations, it can be roughly calculated that the sum of ZEA residues of 26 ng/ml urine, as measured for the current case, corresponded to a mean exposure of the dams of approximately 15 µg ZEA/kg body weight per day. Moreover, the urinary concentration of 26 ng ZEA residues/ml exceeded the so-called exposure threshold of 23 ng/ml, as recently suggested for bovine urine. As the values exceeded this threshold, it would suggest that ZEA exposure of the cow was significantly different from zero (12, 36). In humans, ZEA and some of its metabolites are known to promote hormone-dependent tumours, e. g. breast cancer (3). As a result of its anabolic property, the metabolite zeranol is banned in the European Union (12). The toxin (ZEA) and its metabolites can cause infertility, vulval oedema, vaginal prolapse, mammary hy-

Conclusion for practice

For a final diagnosis of tumours in neonates, a detailed histological and immunohistological investigation is often essential. If congenital tumours occur frequently in a herd, comprehensive investigations should be initiated, including the quality of the feed and water, the hygienic status of animals and animal husbandry as well as the ambient radioactivity. In addition to formalin fixed tissues, veterinary practitioners are recommended to take non-formalin fixed samples and store them frozen for possible further examinations.

pertrophy, reduced milk production in females, and feminization, testicular atrophy and enlargement of mammary glands in males, depending on toxin exposure and animal species (13, 14, 25, 30, 36). ZEA is presumed to be genotoxic and to have chromosomal damaging properties (12). Both genetic defects and mutations cannot be excluded in the present case. Unfortunately, a chromosome analysis was not longer possible in the present case due to the lack of appropriate material available. Based on the measured values, both other mycotoxins and the radioactivity seem to have no relevance in the present case.

Certain tumours are known to be endocrinologically active (20, 35, 37). However, the serum levels of testosterone did not differ between the neonate affected by a Sertoli cell tumour and healthy newborn male calves in the present study. Thus, it can be speculated that the tumour cells did not secrete excessive amounts of this steroid hormone at the time of birth. Schindewolffs et al. (33), who conducted endocrinological investigations on a 32-day-old calf affected by a testicular yolk sac tumour, measured a testosterone blood concentration of 0.04 ng/ml and a total oestrogen concentration of only 13.5 pg/ml. In the present study, the oestrogen concentrations of the calves were beyond the measurement range and are most likely of maternal origin, as periparturient cows exhibit high plasma levels of oestrogens (16). Thus, possible oestrogen production, which is not rare in Sertoli cell tumours in other species (35), could not be evaluated.

Finally, the causal pathogenesis of the congenital Sertoli cell tumour in a neonatal dairy calf cannot be clarified by the investigations conducted. However, the effect of ZEA during pregnancy could not be excluded completely. Thus, further investigations are necessary to elucidate the possible role of prenatal exposure to mycotoxins, and their interactions in the genesis of congenital tumours in cattle.

Conflict of interest

The authors confirm that they do not have any conflict of interest.

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Rezension

Kinesiotaping beim Pferd. Schmerzen lindern – Bewegungen optimieren

Dieses umfassende und doch übersichtliche Buch gibt einen Überblick über die Grundsätze und die praktische Anwendung des kinesiologischen Tapings beim Pferd. Die Autorin ist Tierheilpraktikerin mit zusätzlichen zum Teil speziesübergeifenden Fortbildungen in den Bereichen Osteopathie, Physiotherapie und Sporttherapie.

Das Buch gliedert sich in vier Teile: Der erste und ausführlichste Teil befasst sich mit dem Grundlagenwissen über Tapingbehandlung, anatomischen und physiologischen Grundlagen, Indikationen und verschiedenen Tapeanlagen am Pferdekörper. Die ausführlichen Erläuterungen im Text werden durch Schemata und detailreiche Fotografien ergänzt, die den Inhalt leicht nachvollziehbar werden lassen. Farbig unterlegte Kurzzusammenfassungen runden die einzelnen Unterkapitel in prägnanter Weise ab. „Praxistipps", „Merksätze" oder „Cave"-Kästchen geben zusätzliche Hinweise darauf, was in der praktischen Anwendung der Methode besonders zu beachten ist. Im zweiten Teil geht die Autorin auf die Befunderhebung vor einer Tapeanwendung sowie verschiedene Behandlungstechniken ein. Der dritte, auch sehr umfangreiche Abschnitt gibt einen Überblick über die klinischen Anwendungsmöglichkeiten der Tapingmethode. Für jedes Krankheitsbild werden anatomische Fakten, Ursachen oder Symptome, Behandlungsziele und Therapiemethoden übersichtlich dargestellt. Die Step-by-step-Anleitungen ermöglichen ein genaues Umsetzen der Anleitungen. Auch dieser Abschnitt ist reich an Schemazeichnungen und Fotografien, die die Techniken veranschaulichen. Bestehen verschiedene Tapeanlagen für das gleiche Krankheitsbild, werden diese tabellarisch zusammengestellt. Der vierte Abschnitt beinhaltet weiterführende Literaturangaben. Außer veterinärmedizinischen Standardwerken gibt die Autorin hauptsächlich eigene Werke zu alternativen Therapiemethoden beim Pferd an. An die Literaturangaben schließen sich ein Abbildungs- und Stichwortverzeichnis an.

Zusammenfassend kann festgehalten werden, dass es sich beim kinesiologischen Taping um eine die Schulmedizin unterstützende Methode bei Erkrankungen/Verletzungen des Bewegungsapparats handelt, die den Ansprüchen vieler Pferdebesitzer nach alternativer, nebenwirkungsfreier und ganzheitlicher Behandlung gerecht wird. Bei dem Buch handelt es sich um ein Unikat auf dem deutschen Markt, das einen umfassenden Einblick in diese bisher wenig beachtete Therapiemethode beim Pferd gibt.

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