

Diagnosis of Horn Cancer through Thermography and Its Surgical Management in Cattle

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ABSTRACT

Horn cancer is one of the most prevalent cancers among all neoplastic conditions impacting the bovine population and productivity. A reduction in draught performance, milk production and general well-being leads to considerable economic loss to the farmers. The present study was aimed to diagnose horn cancer early through thermography and its timely surgical management in cattle. The present study involved 34 cases of first-degree horn cancer in bullocks (31/34) and cows (3/34) presented at the Veterinary College Clinic in Junagadh (Gujarat, India) and the area around Junagadh during the year 2024. The study revealed the highest incidence of horn cancer in Gir and Kankrej cattle (47.06% each) predominantly affecting castrated male animals (91.18%). In cases with first-degree horn cancer, shaking of the head, rubbing of the horn on hard objects, nasal discharge from the affected side of horn and lachrymation were the predominant clinical signs. The most affected age group was 6-10 years (52.94%) and the left horn was more frequently involved (67.65%). All the animals passed through thermography showed consistent higher temperature in affected than non-affected horns, proving it a reliable non-invasive diagnostic tool. This was followed by surgical amputation of affected horn and histopathological confirmation, which identified squamous cell carcinoma (6 cases) and other conditions like papilloma, dysplastic changes, myxomatous growths and normal horn tissue without pathological changes.

Key words: Cattle, Histopathology, Horn cancer, Surgical management, Thermography.

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INTRODUCTION

India is renowned for its rich cattle genetic resources, considered a goldmine of exceptional germplasm. Cattle play a crucial role in the agricultural economy, accounting for 35.93% (192.52 million) of the global cattle population and contributing 48% of the milk produced globally (2019 Livestock census). Horn cancer, a type of squamous cell carcinoma, is the most common neoplasm in bovines, comprising 83.34% of all reported bovine tumours (Singh and Singh, 2005). Horn cancer significantly impacts bovine health and productivity, causing agricultural economic losses (Bamne *et al.*, 2007). Though the exact cause of horn cancer is unknown, genetic predisposition, hormonal imbalances (particularly in bullocks) and external factors like horn irritation from yoke friction, tying ropes, shaping, painting or prolonged sun exposure are major contributors to the development of horn cancer, particularly in cattle breeds with long and massive horns such as Kankrej and Gir as compared to other breeds.

Understanding the prevalence, causative agents and predisposing factors is crucial for preventing horn cancer. Diagnosis primarily relies on clinical signs and the animal's history, but this method is only effective once symptoms appear, indicating that the cancer has already developed. Unfortunately, once horn cancer progresses, surgical intervention remains the only treatment option. Infrared thermography is a non-invasive diagnostic tool that aids in the early detection of horn cancer, even before all the clinical signs appear. This technique works through detecting infrared radiation emitted by an object and presenting

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surface temperature as a pictorial representation (Kunc *et al.*, 2007). It identifies abnormal thermal patterns that may suggest the presence of cancer, without requiring direct contact or complex equipment.

Thermography works by converting surface heat emitted by an object into a visual representation, detecting temperature variations through a colour scale (rainbow illustrated pattern), with each colour representing a specific temperature range (Purohit and McCoy, 1980; Turner, 1991).

This technique is particularly useful in identifying neoplasms, as neoplastic cells produce heat, creating a distinct thermal pattern in affected tissues compared to healthy ones. The temperature difference results from increased metabolic activity and altered blood flow associated with neoplastic growth (Singh and Singh, 2020; Casas-Alvarado *et al.*, 2022). Based on this view, this study was carried out with the objective to diagnose horn cancer through infrared thermography in cattle, followed by its surgical management and histo-pathological confirmation in cattle.

MATERIALS AND METHODS

The present study was carried out at the Department of Veterinary Surgery Radiology, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Junagadh (Gujarat, India) and the area around Junagadh during year 2024 for standardization of thermography for diagnosis of horn cancer and its early management. Whole study was performed in cattle affected with first-degree horn cancer.

During the present study, the animals were first screened based on only clinical signs like frequent shaking of the head, rubbing of the horn on the hard object, slimy discharge from the nostril of the affected side and lachrymation from the eye as a sign of first-degree horn cancer. During the study clinical screening of 2900 animals was performed, among which 105 animals were presented with the either one or more signs of first-degree horn cancers, which were selected for thermography of horn.

Thermography

Based on the complete clinical examinations, cattle that suffered from first-degree horn cancer were examined through a thermographic camera (FLIR T540, FLIR, Estonia). During the thermography, all images were taken at a specific distance of 1.0 to 2.0 m from the forehead of the animals and measured the temperature mainly at the base of the horn. After the thermographic examination, a thermogram was analyzed according to Eddy *et al.* (2001) and horn amputation was performed in which higher thermographic temperature was found during the examination (white colour hot spot area in thermogram) (Fig. 1-3).

Pre-Operative Clinico-Physiological and Haematological Examination

The clinical observations like measurement of rectal temperature, respiration rate, heart rate, mucous membrane colour, presence of early clinical signs of horn cancer were recorded. Collection of the blood samples was done in each case after thermographic examination. In the haematological analysis parameters, *viz.*, haemoglobin, packed cell volume, total erythrocyte count, total leucocyte count, differential leucocyte count and platelets were analyzed by auto-blood analyzer on the day of surgery and 12th postoperative day.

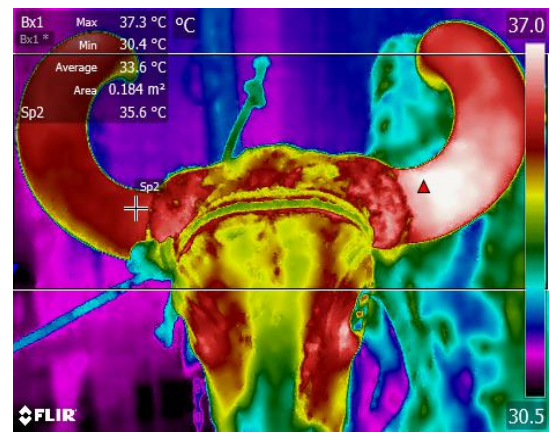


Fig. 1: Gir cattle: Thermogram showing maximum thermographic temperature at left horn base (37.3 °C) compared to right horn base (Sp2: 35.6 °C) with a white hotspot area at the left horn base.

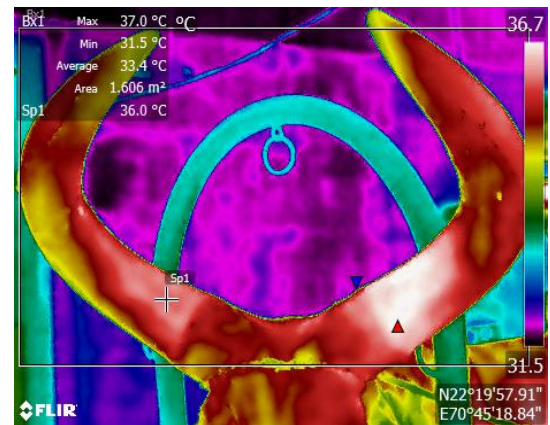


Fig. 2: Kankrej cattle: Thermogram showing maximum thermographic temperature at left horn base (37.0 °C) compared to right horn base (Sp1: 36.0 °C) with a white hotspot area at the left horn base.

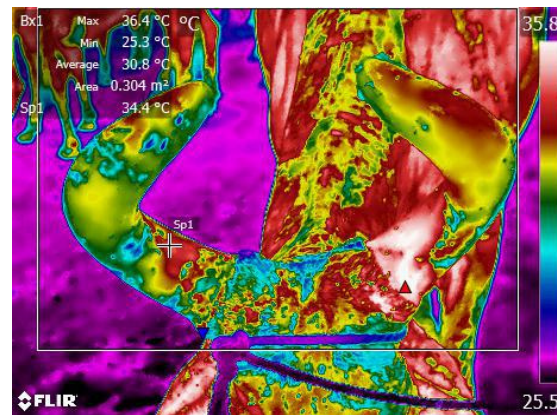


Fig. 3: Kankrej cattle: Thermogram showing maximum thermographic temperature at left horn base (36.4 °C) compared to right horn base (Sp1: 34.4 °C) with a difference of 2.0°C.

Surgical Amputation of Horn

Pre-operatively, Inj. Strepto-penicillin @ 10,000 IU/kg b.wt. and Inj. Meloxicam @ 0.3 mg/kg b.wt were given intramuscularly in every case. Animals were kept off feed and of water for 24



h and 12 h, respectively, prior to the surgery. Among all, 24 cases were operated in a standing position, while 10 cases were managed in lateral recumbency. For lateral recumbency, intravenous injection of Xylazine hydrochloride @ 0.03 mg/kg was given for sedation. After complete restraint surgical site was prepared for aseptic surgery by shaving, scrubbing and regional anaesthesia via cornual nerve block using 2% Lignocaine hydrochloride, and horn amputation was performed through routine flap method in cattle. After that, the frontal cavity and sinus were cleaned with an antiseptic water solution and tumour growth with the epithelial layer was removed. The two edges of the skin flap were brought together in close apposition to each other without tension by cutting the extra bone with a chisel and hammer. The entire skin flap was sutured by horizontal mattress sutures, covered by tincture benzoin seal and bandaged (Fig. 4).

Post-operatively Inj. Strepto-penicillin @ 10,000 IU/kg b.wt., and Inj. Meloxicam @ 0.3 mg/kg b.wt., were given i/m up to 5 days after surgery. Antiseptic dressing of the suture line was done with the 5 % povidone-iodine solution up to healing and the sutures were removed on the 12th postoperative day. Complications, if any, during and after surgery were recorded.

Gross and Histopathological Examinations

The gross changes in the amputated horns was noted at the base, horn core, middle of horn and at the tip of the horn by transverse sectioning. The horn core tissue samples

were collected in 10% neutral buffered formalin from three different sites of horn after transverse sectioning and processed for histopathological examination with hematoxylin and eosin staining using the standard procedure as per Luna (1968).

Statistical Analysis

Data on clinical findings and different haematological parameters were analyzed by paired “t” test using the software GraphPad Prism 10.4.0.

RESULTS AND DISCUSSION

In the present study, 34 cases of first-degree horn cancer were successfully managed. Each case was initially diagnosed based on clinical signs, followed by a thermographic examination of the horn. Finally, the diagnosis was confirmed through histopathological examination of the affected horn tissue.

Risk Factor wise Incidence

The clinical study revealed a similar incidence of horn cancer in Gir and Kankrej cattle, with 16/34 cases (47.06%) reported in each breed, while 2/34 cases (5.88%) occurred in non-descript breeds. Most cases were observed in the 6-10 years age group (18/34, 52.94%), followed by 11-15 years (13/34, 38.24%) and 16-20 years (3/34, 8.82%), with no cases reported below 5 or above 20 years. Male cattle (bullocks) showed a higher prevalence (31/34, 91.18%) compared to females (3/34, 8.82%). Additionally, the left horn was more



Fig. 4: Surgical steps followed in amputation of cancerous horn, Cornual nerve block, circumferential incision at the base forming skin flap, cutting of diseases horn from the base by hacksaw blade, amputated horn core, stitched skin flap, animal during post operative.

commonly affected (23/34, 67.65%) than the right horn (11/34, 32.35%). Naik *et al.* (1969), similarly observed the highest incidence in Kankrej cattle (19.41%), followed by Gir cattle (12.19%), and similar was trend in study conducted by Joshi (1983), with higher incidence in Kankrej (72.24%), followed by Gir (24.54%) and non-descript cattle (1.22%). Age-wise, higher incidences were noted in the 6-10 years group by Naik *et al.* (1969), Kaul and Kalra (1973), Chauhan (2019) and Mahla *et al.* (2021). Sex-wise, bullocks showed a higher prevalence similar to Kaul and Kalra (1973), Joshi *et al.* (2009) and Jaiswal *et al.* (2014). Regarding horn involvement, Udharwar (2004) and Chauhan (2019) found that left horn was more frequently affected (66.7, and 60.0% respectively), while Gholve (2002) and Panchal *et al.* (2024) found similar involvement of both right and left horn.

Gir and Kankrej cattle are more prone to horn cancer due to their large, prominent horns and their males being used for draught purposes, particularly in their native tract of Junagadh and surrounding areas. The higher incidence in cattle aged 6 to 10 years is due to the gradual development of the disease, often manifesting in adulthood when animals face increased physical stress, repeated injuries and prolonged exposure to environmental irritants. In bullocks, castration-induced hormonal imbalances further heighten the risk, alongside factors such as friction from yokes, lead-based paints on horns, and trauma from open wounds. Environmental exposures like sunlight, chemicals and restraint practices may also add stress to one horn, increasing the likelihood of cancer development more in one side.

Thermography

During the thermographic examination, 34 cases were found positive for horn cancer among 105 animals screened. During the thermographic examination, horn temperatures ranged from 31.2 °C to 40.6 °C. Out of 34 cases, in one case temperature, was recorded between 34 and 34.9 °C, five cases ranged between 35 and 35.9 °C, nine cases ranged from 36 to 36.9 °C, eight cases were between 37 and 37.9 °C, seven cases had temperatures from 38 to 38.9 °C, three cases were between 39 and 39.9 °C and one case recorded between 40 and 40.9 °C.

In the thermography, the affected horns exhibited a minimum temperature of 34.8°C and a maximum of 40.6°C. The mean temperature of the affected horns was $37.24 \pm 0.22^\circ\text{C}$, while for the contralateral non-affected horn, it was $36.04 \pm 0.28^\circ\text{C}$. Statistically the difference was significant. and the value of the paired difference was $1.20 \pm 0.16^\circ\text{C}$.

Thermography revealed distinct temperature patterns in the affected and unaffected horns (Fig. 1-3). Using a simple 'rainbow' colour scale (warmest areas shown as white and red, cooler areas as green and yellow, and coolest as blue and black), temperature variations were clearly visualized. The affected horn showed bright white hotspots, indicating

maximum temperature. These hotspots serve as reliable markers for detecting and diagnosing horn cancer by highlighting abnormal thermal patterns. Hovinen *et al.* (2008) found a 1-1.5°C rise in udder temperature during clinical mastitis, reaching a maximum of 39.8°C. Pavelski *et al.* (2015) noted that mammary glands in dogs with tumours had an average temperature of 37.86°C, which was 2.79°C higher than healthy glands. Rokad (2022) reported a 1-2°C increase in thermographic temperature in glands with mammary tumours, while Alessandro *et al.* (2024) observed a 1.5°C difference between cancerous and healthy breast tissue in women. It is proved that the neoplastic cells generate more heat than normal cells, creating a distinct thermal pattern detectable via infrared imaging. This arises from increased metabolic activity, which demands more oxygen and nutrients, leading to angiogenesis and vasodilation (widening of vessels) to enhance blood flow. Nitric oxide (NO) further promotes vasodilation, while pro-inflammatory substances like prostaglandins and histamine contribute to inflammation, boosting blood flow and elevating local temperatures.

Haematological Findings

Among the haematological parameters, the values of neutrophils count decreased and lymphocytes increased highly significantly on day 12 post-operative as compared to 0 day values, while all other parameters remained within normal physiological range without significant alterations (Table 1).

Table 1: Mean \pm SE values of haematological parameters on day 0 and 12th of surgery

Parameter	Day 0	Day 12	p-value
Haemoglobin (g/dL)	9.88 \pm 0.31	9.51 \pm 0.24	0.0590
PCV (%)	30.03 \pm 1.31	30.22 \pm 1.30	0.8506
TEC ($\times 10^6/\mu\text{L}$)	5.88 \pm 0.26	5.43 \pm 0.30	0.1013
Platelets ($\times 10^5/\mu\text{L}$)	2.83 \pm 0.16	2.91 \pm 0.11	0.6138
TLC ($\times 10^3/\mu\text{L}$)	8.08 \pm 0.63	7.64 \pm 0.47	0.5849
Neutrophils (%)	41.4 \pm 1.11 ^a	36.33 \pm 1.01 ^b	<0.0001
Lymphocytes (%)	50.86 \pm 1.21 ^a	56.15 \pm 1.27 ^b	<0.0001
Monocytes (%)	6.20 \pm 0.30	6.15 \pm 0.41	0.9157
Eosinophils (%)	1.41 \pm 0.19	1.23 \pm 0.14	0.4877
Basophils (%)	0.12 \pm 0.06	0.13 \pm 0.06	0.9366

Means bearing different superscripts (a, b) between groups differ significantly ($p \leq 0.05$).

Pathomorphological Findings

Transverse sections of the middle part and tip part of the horn as well as the section at base showed various gross pathological changes in horn core. Some of the cases revealed presence of jelly like myxomatous growth at base, with or without involvement of middle shaft and tip of horns. The representative gross photographs of a typical first-degree horn cancer case showing presence of jelly like



myxomatous growth at base, middle and tip parts, while in another case only yellowish thickened horn core line without any other growth in middle or tip are depicted in Fig. 5 and 6, respectively.

The observations indicate that horn cancer initially develops in the middle or distal regions of the horn core. Over a time, it expands inward and downward, filling the core, reaching the horn's base, and spreading into the frontal sinus. Similar findings were reported by Prajapati *et al.* (1987), Soni (2007) and Joshi *et al.* (2009), who suggested that development of the cancerous growth started from mid to distal end of the horn and progressed towards base of the horn. The development of horn cancer typically starts in the mid to distal regions of the horn due to several potential factors. These areas are often more exposed to external environmental stresses, physical trauma and bacterial contamination, which can irritate or damage the horn tissue. This repeated exposure may lead to cellular changes over time, creating an environment more susceptible to abnormal cell growth and tumour formation. Additionally, the mid to distal regions may have a lower blood supply compared to the base of the horn, limiting the area's ability to repair itself effectively after damage. This combination of external exposure and reduced regenerative capacity can contribute to the initiation of cancerous growth in these parts of the horn.

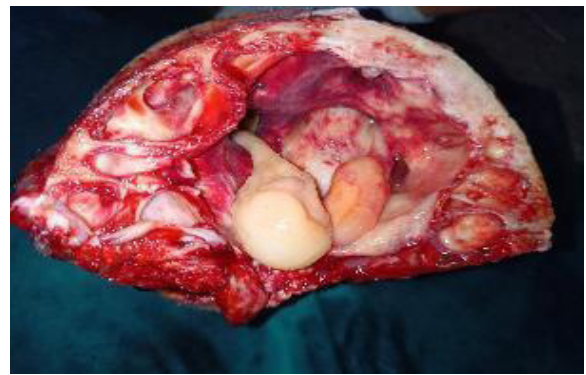
Histopathological Changes

Out of a total of 34 cases examined, squamous cell carcinoma was detected in 6 cases, papilloma was identified in 3 cases, 9 cases were observed with myxomatous growth and 6 cases exhibited various dysplastic growth accompanied by inflammatory changes. The remaining 10 cases showed no pathological changes in horn core.

Microscopic study revealed presence of normal horn core tissue with ciliated and non-ciliated pseudostratified columnar epithelial lining (Fig. 7A, B) at the section of base. The well-differentiated squamous cell carcinoma revealed presence of typical keratin pearl (Fig. 7C) and the presence of cell islands arranged in concentric layers, with squamous cells exhibiting progressive keratinization towards the center (Fig. 7D). In the cases of horn papilloma neoplastic squamous cells arranged in finger like projections with minimal pleomorphism were observed (Fig. 7E). In cases with dysplastic changes, hyperplastic epithelium lined the horn core along with infiltration of inflammatory cell infiltration in subepithelial layer were noticed (Fig. 7F). Myxomatous growth was characterized by multifocal nest of dysplastic cells embedded in myxomatous matrix (Fig. 8A) along with stellate or spindle-shaped cells with indistinct cytoplasmic boundaries, distributed within an abundant myxoid stroma (Fig. 8B).



A) Amputated horn with no external abnormality



B) Section at the base jelly-like growth tissue

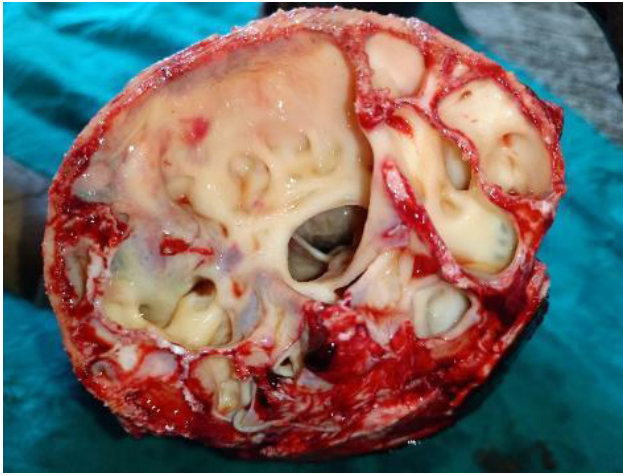


C) Transverse section at middle-part showing myxomatous growth with necrosis of tissue.



D) Transverse section of a tip part showing necrosis of horn core tissue

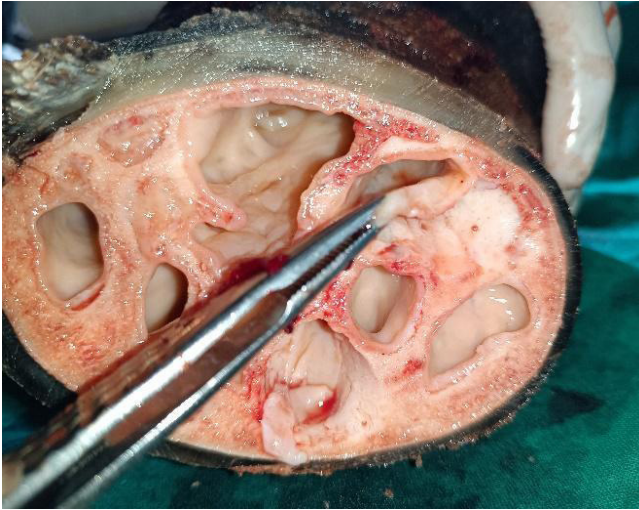
Fig. 5: Representative photographs of case



A) Section at the base showing yellowish thickened horn core line without any other growth



B) Transverse section of the middle part of the horn showing thickening of horn core lining

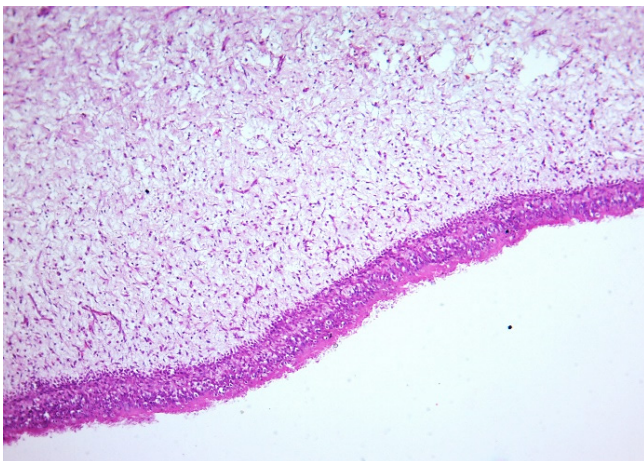


C) Separated thickened layer from horn core

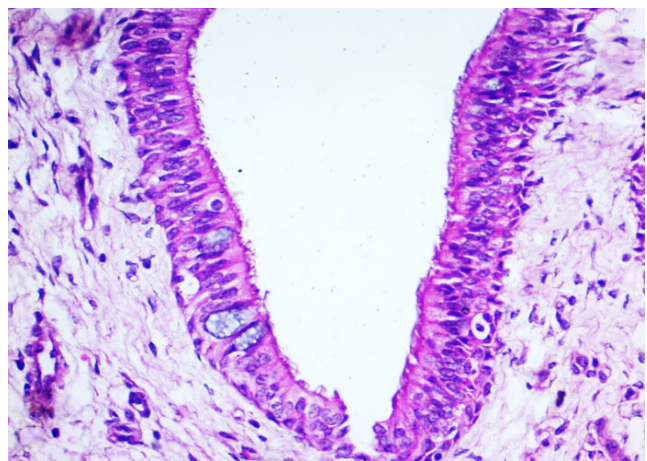


D) Transverse section of the tip part of the horn without any growth

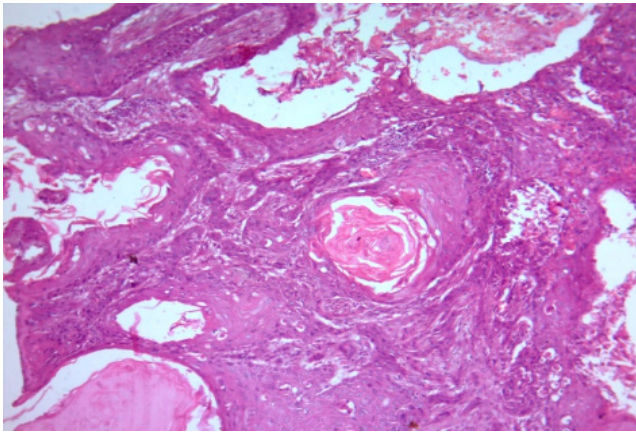
Fig. 6: Representative photographs of case showing gross changes in the horn core, base, middle and tip of the horn



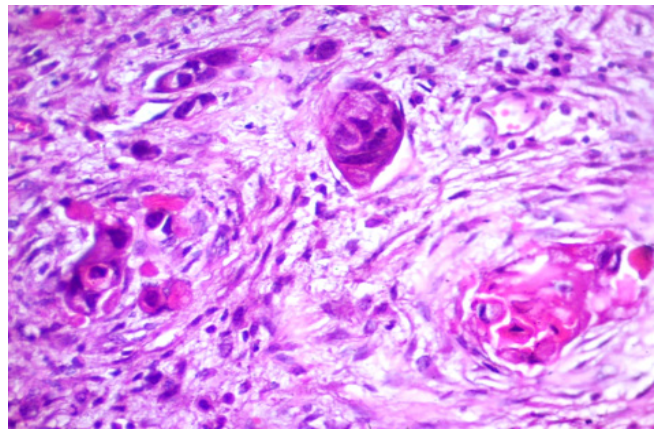
A) Section of base part of horn showing typical pseudostratified columnar epithelial lining (H & E X 100)



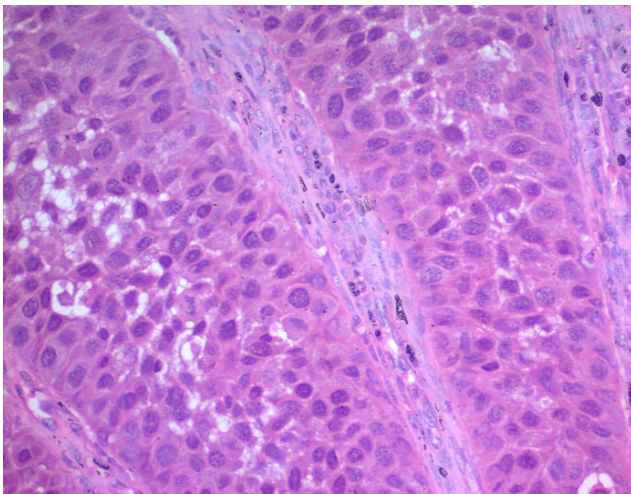
B) Section showing normal typical ciliated pseudostratified columnar epithelial lining of horn core (H & E X 400)



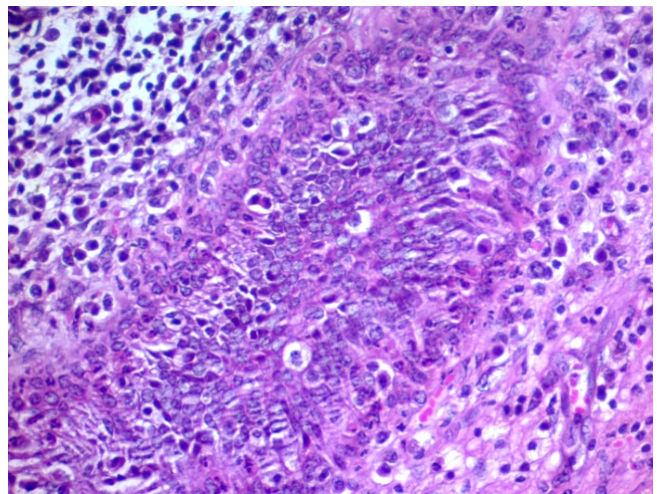
C) Showing typical "keratin pearl" (epithelial pearl) (H & E X 400)



D) Section showing islands of cell consisting of concentric layer of squamous cells increasing keratinization towards the centre along with eosinophil cytoplasm (H & E X 400)

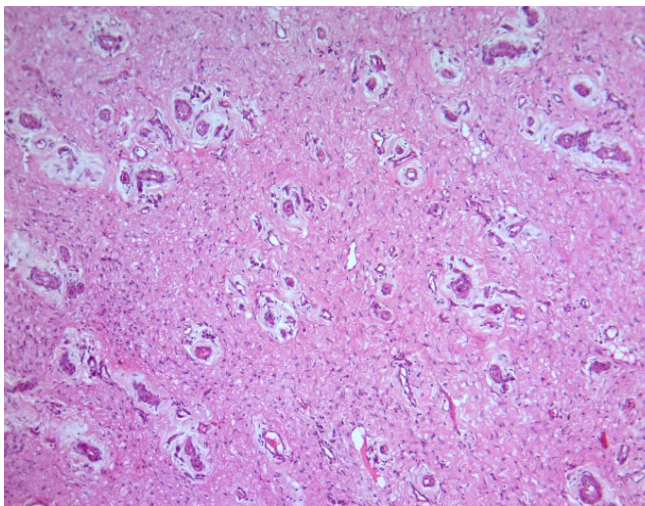


E) Section showing neoplastic squamous cells arranged in finger like projections with minimal pleomorphism (H & E X 400)

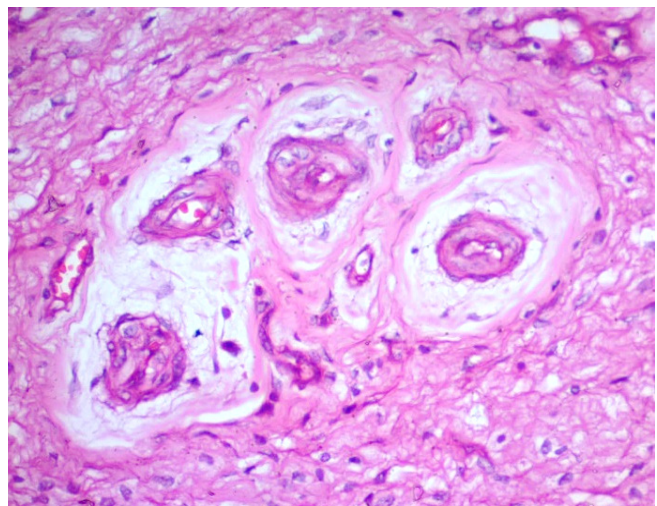


F) Section showing hyperplastic to dysplastic epithelial cells along with infiltration of inflammatory cell infiltration (H & E X 400)

Fig. 7: Histopathology of first-degree horn cancer



A) showing multifocal nest of dysplastic cells embedded in myxomatous matrix (H & E X 100)



B) Section showing dysplastic squamous epithelium cells compactly arranged in concentric manner with eosinophilic cytoplasm (H & E X 400)

Fig. 8: Histopathology of another typical case of first-degree horn cancer.

CONCLUSION

Based on the findings, it is summarized that horn cancer in cattle is one of the most found neoplastic conditions with classical signs. It has a higher incidence in Gir and Kankrej breed and bullocks are more predisposed to this condition. Thermographic analysis demonstrated significant temperature differences (0.3°C to 5.7°C, average 1.2°C) between affected and non-affected horns, proving thermography to be a reliable, non-invasive diagnostic tool for horn cancer and other pathological conditions of the horns. Histopathological analysis identified squamous cell carcinoma, horn tissue papilloma, myxomatous growth, dysplastic changes and inflammatory infiltration, emphasizing the diverse pathological spectrum of horn affections. So, thermography showed high diagnostic potential, but its emissivity might be limited through detecting other inflammatory or neoplastic conditions.

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