Pathology of skin diseases in crocodiles

GN BUENVIAJE, PW LADDS and Y MARTIN
Australian Institute of Tropical Veterinary and Animal Sciences, James Cook University of North Queensland, Townsville, Queensland 4811

Objective To establish which skin diseases occur in crocodiles, particularly those on farms, to indicate the relative frequency of each particular disease and to provide information on pathogenesis, especially in regard to lesions with two or more pathogens present.


Result Skin lesions were obtained from crocodiles on nine farms, from a group of experimental animals and from one adult found dead in the wild. A total of 203 lesions from 180, mostly young, crocodiles was examined; 119 lesions were from retrospectively examined cases and 84 were recent. The relative frequencies of four presumed primary pathogens in lesions were Dermatophilus sp 28.1%, fungi 14.8%, poxvirus 3.4% and probable Mycobacterium sp 2.5%. In addition, other bacteria of unknown significance were present in many lesions, and there was one case of presumed Parichthosoma crocodilus infection. In 32.5% of lesions, multiple pathogens were identified.

Conclusion Dermatophilosis is the most common and probably the most important skin disease of crocodiles in Australia, but it is frequently complicated by concurrent infection with fungi or other microorganisms.

Key words: Crocodile, skin, diseases, pathology, lesions, dermatitis, dermatophilosis, fungi, poxvirus.

Materials and methods

Skin samples were obtained from crocodiles on nine farms (four in Queensland and five in the Northern Territory), and from a group of experimental animals and one crocodile found dead in the wild. A affected crocodile in the Northern Territory had recently been introduced to a farm after capture in the wild. Six of the farms, three in Queensland and three in the Northern Territory were visited between May and August 1996. When representative samples of lesions were obtained, data on morbidity and mortality, possible aetiological agents and other likely predisposing factors, were also collected. The approximate total numbers of crocodiles on these farms varied from 800 to 3000. All data gathered on recent (1996) cases, especially the gross and microscopic findings, were combined for analysis with data on retrospectively examined cases of skin diseases on file in the AITVAS, James Cook University of North Queensland.

Retrospective study

All microslides of crocodile skin lesions on file were re-examined and each lesion was classified according to the suspected or known aetiological agents. For each case the origin, gross and microscopic findings, results of microbiological culture, species, age, length (snout to tail tip) and sex were recorded. A total of 119 skin samples from 109 cases initially received and processed at the AITVAS during the period 1989 to 1995, were included.

Pathological examination

In addition to the retrospective cases, 84 skin lesions from 71 recent (1996 to 1997) cases were examined. These lesions were mostly on emaciated crocodiles that died (28 cases), or were killed by barbiturate overdose for necropsy (34) to ascertain the cause of illness; 9 were obtained by biopsy. More than one skin sample was collected from 23 crocodiles with multiple lesions and in some animals more than one diagnosis was made. Collectively (both retrospective and recent cases), 135 were salt-water crocodiles (Crocodylus porosus), 44 were freshwater crocodiles (Crocodylus johnstoni) and one was of unrecorded species. Their mean length was 82.9 cm (range 25 to 110 cm, n = 121) and ages were between 2 to 36 months (average 15 months, n = 89). Eighty-seven were male, 32 were female and in 84 sex was not ascertained or recorded.

Necropsies were performed either on the crocodile farm, at James Cook University or at the DPIF-BVL, Northern Territory. From each crocodile, three samples of skin of at least 2 cm², and including representative lesions were fixed in 10% buffered neutral formalin and embedded in paraffin wax. For histological examination, sections were cut at 6 µm and stained with haematoxylin and eosin, or other stains such as Gram-Twort for bacteria, Gomori methenamine silver and periodic acid-Schiff for fungi, and Ziehl-Neelsen for mycobacteria. Duplicate specimens of some suspected 'brown-spot' lesions were excised and placed in sterile 5 mL plastic tubes for bacteriological examination, which was commenced at the BV L or...
AITVAS, then continued at the latter, where microbiological procedures used were aimed primarily at isolating the filamentous organism, which was presumed to be the aetiological agent of brown-spot disease. No attempt was made to culture other bacteria.

Results

Table 1 compares the relative frequency of crocodile skin diseases within our collected cases, based on their aetiology and source for the period 1989 to 1997. Five primary diseases, namely dermatophilosis, mycotic dermatitis, poxvirus infection, probable mycobacterial dermatitis and capillariasis, were identified. Two other skin disease categories were mixed infections, and those of undetermined other cause, but with bacteria present superficially. Of the four major skin diseases, dermatophilosis was the most prevalent (57 cases, 28.1%), followed by mycotic dermatitis (30, 14.8%), pox (7, 3.4%), and probable mycobacterial dermatitis (5, 2.5%). Lesions with dual or multiple pathogens present, such as concurrent infections with poxvirus, fungi and dermatophilosis or other bacteria, were common, being present in 66 cases. The 38 lesions classified as ‘other dermatitis’ included a single case of capillariasis (presumably *Paratrichosoma crocodilus* infection); in the other 37 lesions a mixture of both Gram-positive and Gram-negative, but mostly Gram-positive, bacteria were present.

Dermatophilosis

Dermatophilosis was present in crocodiles on six farms. Most affected animals were emaciated and weak, with stunted growth. There were discrete, focal, 1 to 4 mm diameter, brown spots of variable prominence on the skin (Figure 1), predominantly on the ventral abdomen but also elsewhere on the abdomen and on the tail or head. The lesions were situated mostly at the centre of scales or along the ‘hinge joint’ between scales. Lesions on the skin of the lower jaws (19 cases, 33.3%) however, usually presented as linear erosions up to 5 cm in length. In severe cases lesions were large, with irregular ulceration up to 2 cm² diameter on the abdomen (Figure 2). A *Dermatophilus* sp that resembled *D congolensis* both biochemically and morphologically was isolated from five such skin lesions in crocodiles from two farms in Queensland and the Northern Territory.3 Except in some cases of mixed infection, the *Dermatophilus* sp filaments were easily seen in sections stained with haematoxylin and eosin or particularly with PAS.

On the basis of histopathological examination, lesions of dermatophilosis were categorised into three, presumed progressive, stages of brown-spot development. The initial lesion was a focal lifting of the keratin accompanied by some accumulation of debris (Figure 3). *Dermatophilus* sp filaments and occasional Gram-positive coccoid organisms (1 µm diameter), possibly zoospores, were situated in the superficial layer of the epidermis (19 lesions), mostly in the keratinised ‘periderm’,4 but often deeper within intact epidermis. In the next stage of lesion development the epidermis was indented, but still intact, presumably because of continuous replacement of the necrotic cells by hyperplasia of cells of the stratum basale (Figure 4). However, eventual erosion of epidermis frequently seemed to result in the third-stage ulceration (15 lesions, 26.3%), which was accompanied by increased debris, keratin and extension of the filamentous organism into the subcutis, either directly or across remaining eroded epidermis (Figure 5). At this stage, much debris and nuclei, presumably those of parakeratotic cells, were apparent as layers within keratin in 32 of 57 lesions. The debris was composed of necrotic inflammatory cells, keratin and proteinaceous exudate, and was extensively infiltrated at all levels by the filamentous organism (Figure 6). Cholesterol clefts

---

Table 1. Frequency of occurrence of particular pathogens in 203 lesions from 180 crocodiles with dermatitis, based on histological examination.

<table>
<thead>
<tr>
<th>Farm</th>
<th>Dermatophilosis</th>
<th>Poxvirus infection</th>
<th>Mycotic dermatitis</th>
<th>Probable mycobacterial dermatitis</th>
<th>Other causes (mostly bacterial)</th>
<th>Mixed infections</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>17</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>57 (28.1%)</td>
<td>7 (3.4%)</td>
<td>30 (14.8%)</td>
<td>5 (2.5%)</td>
<td>38 (18.7%)</td>
<td>66 (32.5%)</td>
<td>203 (100%)</td>
</tr>
</tbody>
</table>

*a* and 4 in Queensland, 5 and 9 in the Northern Territory, 10 = experimental crocodiles (including one adult from the wild)

*b* Presumed *Paratrichosoma crocodilus* infection

A - Dermatophilosis with other infections, mostly bacteria
B - Dermatophilosis and fungal infection
C - Dermatophilosis and poxvirus infection
D - Concurrent dermatophilosis, poxvirus and fungal infections
E - Poxvirus and fungal infections only
Figure 1. Dermatophilosis ('brown spot'), showing focal, usually discrete, lesions located mostly between scales of the abdomen of a hatchling crocodile (arrow). Bar = 4 mm.

Figure 2. Dermatophilosis. More advanced lesion than in Figure 1. Note irregular ulceration of the skin of the abdomen. Bar = 1 cm.

Figure 3. Early dermatophilosis lesion. Note lifting of laminated keratin, accompanied by debris between layers of keratin. Haematoxylin and eosin, x 123.

Figure 4. Dermatophilosis lesion at a more advanced stage than above. Note excessive superficial debris, hyperplasia of cells of the basal layer (arrowhead), and increased inflammatory cell infiltration of the dermis. Haematoxylin and eosin, x 86.

Figure 5. Dermatophilosis, showing numerous thin filaments infiltrating across the ulcerated epidermis. Haematoxylin and eosin, x 235.

Figure 6. Larger magnification of the lesion in Figure 5, showing irregularly branching filamentous organism on debris composed of cellular infiltrates and degenerating inflammatory cells. Haematoxylin and eosin, x 700.
were sometimes present within this debris. Heterophils were scattered between cells of the epidermis and in the dermis. Other changes were acanthosis, spongiosis and exaggerated formation of rete ridges. Apoptosis and dyskeratosis were also observed in association with acanthosis. The presence of cell debris on affected epidermis, associated with lifting of the keratinised periderm, occurred early (Figure 3), but was an almost consistent change, being present in 86% of lesions. Inflammatory infiltrates in the dermis were mostly (75% of lesions) of lymphohistiocytic type, surrounding the lesion, but specifically around blood vessels. Multinucleate giant cells were present in two lesions associated with the filamentous organisms. In one, they were immediately beneath damaged epidermis, while in the second they were deeper within the dermis. Late in the third stage of development of lesions, ulceration extended to involve a larger area of the dermis and often also the underlying muscle, which in nine cases (15.8%) was infiltrated by *Dermatophilus* sp. Other bacteria were present superficially in all dermatophilosis lesions, but were never observed in deeper tissue.

**Mycotic dermatitis**

Although mycotic dermatitis as a primary disease was the second most frequently seen, only 3 lesions, in a total of 30 diagnosed, were recent, and the prevalence of mycotic dermatitis extrapolated from the data seemed to have declined between 1993 and 1996, with a large number of cases in 1992 and previously. A grey, gelatinous appearance of affected skin was a consistent gross characteristic. Such lesions, which developed over a period of one week or so, were present on any location of the body, but especially on the dorsal skin of the head.

Microscopically, affected skin was mostly ulcerated (16 lesions) or eroded (12 lesions) and in 2 lesions a subcutaneous granuloma was below an intact epidermis, probably indicating that fungi had persisted in this (deep) location after re-epithelialisation of ulcers. Mats of fungal hyphae were on the surface but they often (18 lesions) infiltrated down to the dermis or muscle. Affected epidermis was acanthotic, with heterophilic infiltration. Other consistent microscopic changes were spongiosis, formation of rete ridges and accumulation of debris. Histiocytes, other mononuclear cells and heterophils were widely scattered, but were more densely accumulated near the ulcers. In the subcutaneous granulomas, centrally located fungal elements were surrounded by multinucleate giant cells, histiocytes, and other mononuclear cells, few heterophils and fibrous tissue.

Fungal hyphae were stained strongly by the PAS method. In most lesions they were septate, had a relatively uniform diameter of 2.5 to 3 µm and sometimes branched in a dichotomous manner. This morphological feature was consistent with that of *Fusarium* sp. In several crocodiles mixed accumulations of fungal hyphae, yeast, algae and bacteria were also present superficially on intact skin; as they had not infiltrated the epidermis, however, and as there was no inflammatory response, these organisms were not judged to be pathogenic and were therefore disregarded. Fungi isolated from retrospectively examined cases revealed *Fusarium* sp as the most common isolate (8 of 12 lesions). Other fungi identified were *Candida* sp (2), *Syncephalastrum* sp (2) and single isolates of *Candida parasilosis*, *Aspergillus niger*, *A. flavus* and *Trichosporon cutaneum*.

**Poxvirus infection**

Seven primary poxvirus lesions were seen in five crocodiles from two farms (farms 2 and 3) in Queensland and a further two lesions were on crocodiles from one farm (farm 6) in the Northern Territory. Of the seven poxvirus lesions, four were diagnosed in 1996 while three were retrospective cases. The gross and microscopic lesions were in all cases typical to those infections already reported. Two lesions on the foot were adjacent to the gas-filled spaces of concurrent interdigital subcutaneous emphysema. Ulceration of a further single poxvirus lesion had extended to the deep dermis.

**Mycobacterial dermatitis**

Five lesions of presumed mycobacterial dermatitis were diagnosed in crocodiles from two farms in Queensland. Three were recent cases from farm 2 and two were retrospective (1992) cases from farm 1. Gross examination of affected skin revealed individual, raised, red to grey nodules, 2 to 5 mm in diameter, on the snout, conjunctiva, jaws and along the ventral side of the neck and medial thigh. Histological examination of two retrospective cases showed a well-circumscribed granuloma in the dermis, beneath an intact epidermis. The other three lesions had erosion of the epidermis and accumulations of multinucleate giant cells, histiocytes, lymphocytes and heterophils. Acid-fast organisms in Ziehl-Neelsen stained sections were scattered throughout the granuloma, with some organisms present inside the giant cells.

**Mixed infections**

Of the 66 lesions with demonstrable dual or multiple infections, 62 (94%) contained *Dermatophilus* sp. Most of these lesions were deep ulcers that involved a wide area of the dermis and subcutis. Occasionally, along the edges of the ulcers, there were scattered multinucleate giant cells associated with Gram-positive bacteria. In this particular type of dual infection only a few, usually superficial, *Dermatophilus* sp filaments were present while the bacteria were located deeper within the ulcers. The affected skin was oedematous, congested and sometimes haemorrhagic, and was infiltrated with predominantly heterophils and lymphohistiocytic cells.

Dermatophilosis was also diagnosed as a mixed infection with other bacteria in the adult crocodile that was found dead in the wild. This animal had multiple ulcers up to 40 mm in diameter, which sometimes extended to underlying bone, on both ramus of the mandible. Trauma, perhaps from fighting, was the likely primary cause, with *Dermatophilus* sp and other bacterial infection being secondary. Microscopically, lesions in this case were similar to those in dermatophilosis in farmed crocodiles but, in addition, the filaments were seen inside blood vessels of the deep dermis where they were associated with other Gram-positive bacteria.

**Other causes of dermatitis**

In 20 recently collected lesions there were raised ulcers up to 6 mm in diameter, filled with debris. These lesions were mostly located on the skin of the back and tail. The irregular shape of the ulcers often suggested recent puncture wounds, probably from bites. Microscopically, accumulated debris within the ulcers was associated with numerous bacteria. There was oedema, congestion and inflammatory infiltration of the dermis
composed of heterophils, lymphocytes, macrophages, lymphohistiocytes and some multinucleate giant cells. Adjacent to ulcers were colonies of Gram-positive cocci encircled by multinucleate giant cells and histiocytes. However, on the surface of the lesions there was a mixture of numerous pleomorphic, Gram-positive and Gram-negative bacteria. In addition, intra-dermal inclusion cysts filled with debris, proteinaceous material, inflammatory infiltrates and bacteria, were present close to these lesions.

In a single, 18-month-old *C porosus* that measured about 150 cm in length (snout to tail tip), a striking, dark, serpentine pattern was present on a number of adjacent scales near the cloaca (Figure 7). The crocodile, which was clinically normal and had no other lesions on the skin, had recently been introduced to farm 6 after its capture in the wild. Microscopically, both the keratinised and cellular layers of the epidermis had numerous, slightly irregular, cystic spaces (93 x 175 µm) that contained three to five operculated eggs measuring from 27 µm up to 73 µm (Figure 8) or, in some cases, two to three eggs as well as transverse sections of what was presumed to be a single adult female parasite (Figure 9) with ova in its uterus. Approximate diameter of this nematode as measured in histological sections was 138 µm. The clear cystic spaces in the periderm were smaller than those in the cellular layer of the epidermis, possibly because the absence of adult parasites in the keratin layer permitted greater contraction of keratin during fixation and histological processing. Eggs present in the periderm had scanty basophilic granules, and were presumably those of an embryo in its first to second stage of development. Epidermal cells adjacent to the parasite-containing cystic spaces were flattened.

In one *C porosus* juvenile that died after not eating and being listless for several days, there was extensive necrosis with lifting of entire scales that were easily detached (Figure 10). Necropsy revealed extensive subcutaneous oedema, myolysis and numerous large colonies of Gram-positive bacteria, but few infiltrating inflammatory cells, immediately beneath the detached scales. In addition to the skin lesions, there was a disseminated focal hepatitis and splenitis with bacteria present in the liver. A fulminating bacterial septicaemia was diagnosed.

**Discussion**

Based on the overall results of pathological examination of the 203 lesions, dermatophilosis is clearly the most frequently diagnosed, and probably the most important skin disease in farmed crocodiles in Australia. The typical brown spot in this study pitted the scales to various depths, especially on the abdomen, and sometimes extended to involve the underlying tissues, including muscles, as does brown spot in alligators. An investigation into skin lesions in farmed Nile crocodiles (*C niloticus*) in Zimbabwe also identified the brown-spot lesion as an important skin problem. An organism that culturally resembles *D congolensis* and has been isolated from farmed alligators and crocodiles is considered to be the causative agent.

Dermatophilosis in other reptiles has not been characterised by typical brown-spot lesions; instead, a subcutaneous abscess was seen in Australian bearded lizards (*Amphibolurus barbatus*) and turtles. Microscopic study of later cases in Australian bearded lizards, however, did reveal changes comparable to those in the present study.

Although caution is needed when using spontaneous lesions to interpret pathogenesis, several infected skins in the present study had Gram-positive coccoid organisms (about 1 µm in

![Figure 7. Skin infected with presumed *Paratrichosoma crocodilus*. Note striking black serpentine pattern on the scales. Bar = 5 mm.](image)

![Figure 8. Same section as in Figure 7, showing eggs inside clear cysts in both the keratin and cellular layers of the epidermis. Haematoxylin and eosin, x 79.](image)

![Figure 9. Adult presumed *Paratrichosoma crocodilus* with some eggs, inside the clear cystic spaces of the same section as in Figure 7. Haematoxylin and eosin, x 97.](image)
The presence of dermatophilus sp filaments in 94% of lesions with multiple infections clearly suggests that this organism plays a significant role in causing damage to the skin. Histopathological study of the lesions with multiple infections consistently revealed changes typical of those in primary, ‘uncomplicated’, dermatophilus sp infection. Presumably in such cases, dermatophilus sp initiates the damage to the epidermis, then further invasion by other opportunistic microorganisms follows, particularly in crocodiles whose immune and/or inflammatory responses are compromised by stress. Because dermatophilus sp often grow slowly, other fast-growing microorganisms may aggressively cause ulceration, then invade deeply into the dermis. Some bacteria, especially Bacillus spp are able to produce a substance that inhibits growth of Dermatophilus sp17 so that, in such mixed infections, as observed in 65 lesions in the present study, the filaments were scanty and mostly superficial.

The finding of typical histological lesions of dermatophilosis in the single crocodile that died in the wild is of particular interest. The present and previous studies indicate a high prevalence of Dermatophilus sp in farming environment; its occurrence in the wild emphasises its ubiquitous nature and clearly suggests a likely route for its introduction to farms.

Uncomplicated mycotic dermatitis seems to be no longer a serious problem on Australian crocodiles farms considering that it was the cause of only three lesions diagnosed recently in this study. Retrospectively, however, mycotic dermatitis was a serious disease problem in all farms in Queensland and the Northern Territory18 but, with improved husbandry, especially in regard to provision of a water temperature of 32°C for hatchlings, the occurrence of mycosis has decreased.

The occurrence of poxvirus infection was relatively low on crocodile farms in Australia compared to severe outbreaks with high morbidity in Africa.1 In this present study, the absence of an inflammatory response in many lesions may have been related to a poor immunological response.1

Although mycobacterial infections in alligators20 and other crocodilians21 have been reported, details of histopathological findings have not been described. The ulcerative cutaneous granulomas as found in five lesions in both C porosus and C johnstoni were morphologically similar to cutaneous mycobacteriosis in other reptiles.22 Bacteriological studies were not done in this case, but recent polymerase chain reaction studies on disseminated mycobacterial granulomas in C johnstoni confirmed the presence of Mycobacterium sp.23

The sizes of the operculated eggs and adult worm inside ‘serpentine tunnels’ of one crocodile in this study were consistent with the parasite being Paratrichosoma crocodilus, as observed in infected skin of the New Guinean crocodile (C novaeguineae).24 As the larvae within the eggs in the keratin layer were more developed than those in the epidermis, it seems likely that they mature in the periderm, and are shed with the keratin into the environment. Infection of other crocodiles in the same pen, however, was not observed, again indicating that this infection is essentially restricted to crocodiles in, or recently introduced from the wild.

Acknowledgments
We are grateful to Dr Jill Millan, Vicky Simlesa and others at the Berrimah Veterinary laboratory, Department of Primary Industry and Fisheries, Darwin, Northern Territory for assistance in collecting and examining skin lesions. The help of Associate Professor Bruce Copeman in interpreting skin lesions with Paratrichosoma crocodilus, and Laurie Reilly and Dr Pam Ness for histological processing is appreciated. Special thanks
are extended to all crocodile farms in Queensland and the Northern Territory for their cooperation. This work was funded in part by a grant from the Rural Industries Research and Development Corporation.

References

(Accepted for publication 27 March 1998)

Effects of branding on the welfare of cattle

Branding is used in cattle husbandry to permanently identify cattle. Both common branding methods, hot-iron and freeze branding, cause tissue damage and undoubtedly lead to some degree of pain and discomfort. In two studies, researchers from the University of Saskatchewan observed blood cortisol concentrations, weight gain and ease of handling after the cattle were branded using either of the two methods. They also followed body temperature and the rate of antibiotic use in these cattle, to see if stress of branding affected the immunity to infections.

Thirty, yearling heifers were divided into groups which were either hot-iron branded, freeze branded or not branded. Control heifers were confined in a chute for the same time as the branded heifers. Blood was drawn for analysis of cortisol concentration before branding and at intervals until 3 h after branding or confinement. To measure stress-induced analgesia, the heifers’ pain threshold was assessed at intervals before and after branding by applying heat to a hind leg and observing the foot- lift latency. Sensitivity of the branded skin to touch was assessed 1 and 7 days after branding and compared to the sensitivity of skin on the other side of the animal.

Both branding methods caused an increase in cortisol secretion at 20 and 40 minutes after branding. The effect of hot branding was greater than that of freeze branding. Branding caused no measurable stress-induced analgesia, judging from pain thresholds in branded and control heifers. The branded skin was not sensitive to touch.

In a separate two-part study, the researchers divided cattle into untreated controls, a hot-branded group and a freeze-branded group, with 10 Charolais-cross steers in each. In trial 1 the steers were branded on arrival at a feedlot. Rectal temperature, antibiotic treatments and weight gain were recorded up to 10 days. Whenever the steers were weighed, the amount of handling needed to move them into chutes was graded and recorded. In trial 2, the same procedures were carried out on 248 steers, divided into similar groups, 20 days after arrival at the feedlot.

Branding treatments had no effect on weight gain or the number of antibiotic treatments in either part of the study, but in trial 2 the freeze-branded steers needed more encouragement to enter chutes, suggesting that this method of branding may cause some lingering pain.

The authors conclude that freeze and especially hot-iron branding cause short-term discomfort to cattle, but that long-term effects are not sufficient to hinder weight gain or immunity.