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A SURVEY ON NEOPLASIA IN DOMESTIC SPECIES OVER A 40-YEAR PERIOD FROM 1935 TO 1974 IN THE REPUBLIC OF SOUTH AFRICA IV. TUMOURS OCCURRING IN EQUIDAE

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ABSTRACT

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A survey was carried out on the neoplasms of horses, donkeys and mules which are recorded in the registration files of the Section of Pathology of the Veterinary Research Institute, Onderstepoort, in the Republic of South Africa, over a 40-year period from 1935 to 1974.

A total of 378 tumours are recorded, 339 of which were in horses, 32 in mules and 7 in donkeys. Sarcoids (38%), squamous cell carcinomas (23,5%), fibromas (8,2%), melanomas (8,0%), papillomas (4,5%), fibrosarcomas (3,4%) and lymphosarcomas (3,0%) accounted for 88,6% of the total.

Of the 58 sarcoids for which the site or origin was determined, 46,5% occurred on the head, 32,8% on the chest and abdomen, 19% on the limbs especially below the level of the carpus or hock and 1,7% on the neck.

Fifty percent of the 89 squamous cell carcinomas occurred on or around the eyes, especially on the eyelids or nictitating membrane, 23% involved the penis and/or prepuce, while just over 20% arose on the skin. The melanomas involved the skin and eye, whilst papillomas originated primarily on the skin and less frequently on the penis.

INTRODUCTION

Since 1936, when Jackson (1936) reported on the incidence of neoplasms in domestic animal species in the Republic of South Africa (RSA), there has been no further survey to support or refute his findings. He recorded 119 tumours in horses, mules and donkeys, which included 37% sarcoids, 21% squamous cell carcinomas and 17% melanomas, whilst the remaining 23% comprised a variety of different types. Head (1953), in Scotland, recorded 58% of 52 tumours in Equidae as fibropapillomas, 29% as squamous cell carcinomas, 7% lymphosarcomas and 5,8% as melanomas. Out of 236 neoplasms, Sundberg, Burnstein, Page, Kirkham & Robinson (1977), in the United States of America (USA), recorded an incidence of 43,6% for sarcoids and 24,6% for squamous cell carcinomas. They also reported a relatively high occurrence of melanomas, pipillomas and neurofibromas. Baker & Leyland (1975), however, recorded fibromas in 35,5% of 124 neoplasms as the most commonly encountered tumour, followed by squamous cell carcinomas (15,3%) and sarcoids (12,9%). On the other hand, Damodaran & Ramachandran (1975), in India, and Cotchin & Baker-Smith (1975), in the United Kingdom, reported the commonest type of tumours to be endocrine tumours of the thyroid gland.

The purpose of this survey is to report on the prevailing types and incidence of tumours in Equidae in the RSA and compare them with those reported previously in the RSA and those occurring in Equidae in other countries.

MATERIALS AND METHODS

The material for this survey was obtained from formalin-fixed tissues submitted by private or state veterinarians and stock inspectors from all parts of the RSA to the Section of Pathology of the Veterinary Research Institute, Onderstepoort.

The registration files and written reports for each year of the survey were carefully screened and all the cases diagnosed as tumours were noted. The pertinent data for all the tumours in Equidae, i.e., horses, donkeys and mules, were recorded in a separate registration file. These tumours were then tabulated according to their type and tissue or organ of origin. For the more common tumours the specific sites of origin within a particular tissue were also recorded and tabulated.

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The neoplasms reported in Equidae for the first 15 years of the survey (1936–1951) were recut and examined under the light microscope. All tumours referred to by terms which are no longer used were renamed and tabulated, using only the present-day terminology.

RESULTS

A total of 378 tumours were recorded, 339 of which were in horses, 32 in mules, and 7 in donkeys. These tumours have been tabulated according to their type and organ or tissue of origin (Table 1). Additional details as regards equine sarcoids, squamous cell carcinomas, melanomas and papillomas have been tabulated in Tables 2–5.

Seven types of tumours accounted for 88,6% of the total 378 tumours (Table 1). These included 144 sarcoids (38%), 89 squamous cell carcinomas (23,5%), 31 fibromas (8,2%), 30 melanomas (8,0%), 17 papillomas (4,5%), 13 fibrosarcomas (3,4%) and 11 lymphosarcomas (3,0%).

The specific site of origin on the body could be determined for 58 of the sarcoids (Fig. 1 & 2) (Table 2). Twenty-seven (46,5%) of the sarcoids occurred on the head, 19 (32,8%) were on the trunk (chest or abdomen), 11 (19%) on the limbs and 1 (1,7%) on the neck. Of the sarcoids on the head, 11 (41%) were situated on the ears (either on the pinna or deeper in the ear canal), while 4 (15%) were on the eyelids. The remaining 12 (44%) sarcoids on the head included 1 on the conjunctiva, while the rest occurred at various sites on the face (Table 2). Only 3 sarcoids were reported on the chest. Out of 14 tumours on the abdomen, 10 were seen on the ventral parts of the abdomen including the skin of the prepuce, scrotum or udders. Only 2 of these 58 cases of sarcoids arose from multiple sites on the body. Eleven sarcoids were recorded on the limbs. Six of the 8 sarcoids on the limbs, the site of origin for which could be determined, involved the skin below the level of the carpus or hock (Table 2).

Squamous cell carcinomas accounted for 89 (23,5%) of the total neoplasms (Table 1), 50% of which occurred on the eye, in particular on the eyelids or nictitating membrane (Table 3). The male genital tract accounted for 23% of the squamous cell carcinomas, all of which involved the glans penis or prepuce or both. Eighteen (20,1%) of these neoplasms arose on the skin, while the remaining 4 (4,6%) occurred either on the vulva and vagina or clitoris, or on the larynx (Table 3).

TABLE 1 Tumours in Equidae from 1935 to 1974

Type	Tissue/organ/body system	Number	Percentage of 378 neoplasms
Sarcoid	Skin and subcutis	144	38,0%
Squamous cell carcinoma	Skin/eye/genital tract	89	23,5%
Melanoma	Skin/eye	30	8,0%
Papilloma	Skin/oral cavity/genital tract	17	4,5%
Sebaceous gland adenoma Lacrimal gland adenoma	Skin/eyelid	2 2	1,1%
Fibroma Fibrosarcoma Myxoma Undifferentiated sarcoma	Connective tissue	31 13 1 1	12,2%
Lymphosarcoma Leukaemia	Lymphoid/myeloid tissue	11 1	3,2%
Osteoma Osteosarcoma Osteochondroma Synovioma	Bones/joints	2 1 1 1	1,3%
Lipoma Liposarcoma	Adipose tissue	6 1	1,9%
Haemangioma Haemangiosarcoma	Blood vessels	1 5	1,6%
Leiomyoma	Muscle	2	0,5%
Pulmonary adenocarcinoma Nasal carcinoma	Respiratory system	1 1	0,5%
Hepatocellular carcinoma	Liver	1	0,3%
Neurofibroma Ependymoma	Nervous system	4 1	1,3%
Thyroid adenoma Thyroid adenocarcinoma	Endocrine system	1 1	0,5%
Fallopian tube adenoma Mesothelioma (peritoneum) Undifferentiated carcinoma	Miscellaneous	1 1 4	1,6%
Total		378	100%

FIG. 1 Sarcoid. Long rete pegs (arrow) of the epithelial component extending into the fibrous portion of the tumour: HE × 75

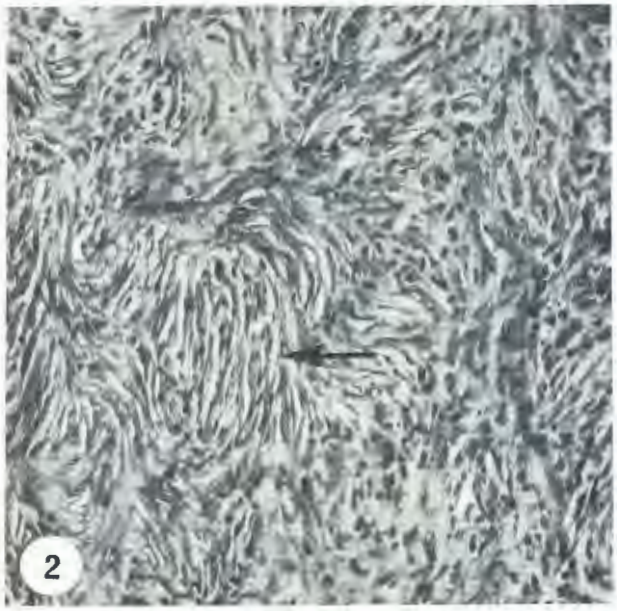

FIG. 2 Sarcoid. Fibroblasts running in different directions. Note neurofibroma-like area (arrow): HE × 200

TABLE 2 Specific distribution of 58 sarcoids

Part of body	Region	Specific site	Number	Total	Percentage of 58 sarcoids
Head	Ear	Pinna or meatus	11	27	46,5%
	Eye	Eyelid	4		
		Conjunctiva	1		
	Face	Mandibular area	4		
		Frontal area	1		
		Supraorbital area	1		
		Lip	3		
		Nostril	2		
Neck			1	1	1,7%
Trunk	Thoracic region		3	19	32,8%
	Abdominal region	Flank	2		
		Back	2		
		Perineum	2		
		Belly	1		
		Groin	2		
		Udder	1		
		Prepuce	3		
		Scrotum	1		
	Multiple on trunk		2		
Limbs	Above carpus/hock	Thigh	1	11	19,0%
	Carpus/hock		1		
	Below carpus/hock		6		
	Site unknown		3		
Total				58	100%

TABLE 3 Sites of origin of 89 squamous cell carcinomas

Organ/system/region	Specific site	Number	Total	Percentage of 89 tumours
Eye	Eyelid	16	45	50%
	Nictitating membrane	13		
	Cornea/sclera	3		
	Conjunctiva	2		
	Site unknown	11		
Face	Nose	1	2	2,3%
	Frontal region	1		
Male genital system	Glans penis	11	20	23,0%
	Prepuce	7		
	Glans penis and Prepuce	2		
Female genital system	Vagina/clitoris	1	2	2,3%
	Vulva	1		
Respiratory system	Larynx	2	2	2,3%
Skin	Site unknown	18	18	20,1%
Total			89	100%

Tumours of mesodermal origin occurred relatively frequently and made up 58 of the 378 tumours (Table 1). Of the 44 neoplasms of fibrous tissue origin 31 were fibromas and 13 fibrosarcomas, whilst the remaining 2 comprised a myxoma and an undifferentiated sarcoma. The remaining neoplasms included 7 lipomas, 1 liposarcoma, 4 osteomas, 1 osteosarcoma, 1 osteochondroma and 1 synovioma (Table 1).

Out of the 30 melanomas, 11 (36,6%) were malignant, 5 (16,7%) were benign, whilst the histological designation of the remaining 14 (46,7%) was not stated (Table 1 & 4). The skin accounted for 20 (66,6%) of the 30 melanomas. The eye was the second most frequently affected site with 4 (13,3%) of the total melanomas, while another 4 were recorded from the respiratory or male genital systems. The primary site of origin for the remaining 2 melanomas could not be ascertained (Table 4).

Seventeen papillomas were recorded (Table 1). The skin accounted for 11 (64,7%) of these neoplasms (Table 5). A relatively high proportion, 3 (17,6%), occurred on the penis, whilst the remaining 3 tumours arose in the oral cavity or on the nictitaing membrane (Table 5).

Besides tumours of the adipose tissue and the skeletal system, which have been included amongst the tumours of mesodermal origin, the remaining neoplasms included a variety of types arising from the eyelid, blood vessels, muscle, liver, peritoneum and fallopian tube, as well as from the respiratory, nervous and endocrine systems

TABLE 4 The sites of origin of 30 melanomas

Tissue/system	Site	Histological designation	Number	Total	Percentage of 30 tumours
Skin	Undetermined	Not stated	7	20	66,6%
		Malignant	5		
		Benign	3		
	Groin	Not stated	1		
	Back	Not stated	1		
	Perineum	Malignant	1		
		Benign	1		
	Multiple sites	Not stated	1		
Eye	Eyelid	Not stated	1	4	13,3%
		Benign	1		
	Conjunctiva	Not stated	1		
	Sclera	Malignant	1		
Respiratory system	Nasal cavity	Malignant	1	2	6,7%
	Nostril	Malignant	1		
Male genital system	Glans penis	Not stated	1	2	6,7%
	Scrotum	Not stated	1		
Metastatic sites	Liver	Malignant	1	2	6,7%
	Muscle, Lymph node and cervical vertebrae	Malignant	1		
Total				30	100%

TABLE 5 The specific sites of origin of 17 papillomas

Tissue/system	Site	Number	Total	Percentage of 17 tumours
Skin	Jaw	1	11	64,7%
	Neck	1		
	Ear	1		
	Leg	1		
	Unknown	7		
Oral cavity	Lip	1	2	11,8%
	Not stated	1		
Eye	Nictitating membrane	1	1	5,9%
Male genital tract	Penis	3	3	17,6%
Total			17	100%

(Table 1). Of the 5 nervous tissue tumours, 4 involved the peripheral nervous system (neurofibromas). The 2 tumours of the endocrine system occurred in the thyroid gland.

DISCUSSION

The 7 types of tumours which were the most frequently encountered in this survey and which accounted for 88,6% of the total neoplasms were sarcoids (38%), squamous cell carcinomas (23,5%), fibromas (8,2%), melanomas (8,0%), papillomas (4,5%), fibrosarcomas (3,4%) and lymphosarcomas (3%). In a retrospective study of 236 neoplasms in Equidae in the USA, Sundberg *et al.* (1977) recorded a similar incidence for some of these tumours. In previous surveys conducted in this country and in the USA, sarcoids reportedly constituted a high proportion of tumours in Equidae (Jackson, 1936; Sundberg *et al.*, 1977; Strafuss, Smith, Dennis & Anthony, 1973). On the other hand, Head (1953) and Baker & Leyland (1975) in the United Kingdom respectively recorded fibropapillomas and fibromas to be the most frequent neoplasm of Equidae.

There is still controversy as to the exact histological appearance of the equine sarcoid. Jackson (1936), the first worker to describe the nature of sarcoids in horses, adapted the term "equine sarcoid" from the human pathology, as these tumours in man have a biphasic nature, being composed of both dermal and epidermal elements. Ragland, Keown & Spencer (1970) concur with Jackson's original description that the equine sarcoid is biphasic in nature and they briefly refer to equine sarcoids as "fibropapillomas". They did note, however, that although the majority of equine sarcoids conform to Jackson's description, the epidermal component is not necessarily always present. They reported that 2 sarcoids amongst a series of 72 lacked the epithelial component. Both were regarded as equine sarcoids because, firstly, histologically they had the appearance of the dermal component of sarcoids and, secondly, they occurred on a horse on which a third tumour, a typical biphasic sarcoid, was also present. In view of the above it is possible that the fibropapillomas in the survey conducted by Head (1953) could have been sarcoids.

Baker & Leyland (1975) recorded 35,5% out of 124 equine tumours as fibromas and only 12,9% as sarcoids. They stated that it can be difficult to differentiate these 2 neoplasms from each other microscopically. In their opinion, a proportion of fibromas have extremely sharply demarcated edges and no overlying epithelial component, whilst some do have an overlying epithelial component, but no long rete pegs and no so-called "picket fence pattern" (where the uppermost layer of fibroblasts in a sarcoid are arranged at right angles to the basement membrane of the epithelium), as is the case in sarcoids.

All fibromas, according to Baker & Leyland (1975), have area with organized fibre components, although the fibres may be of variable maturity and irregularly or randomly arranged, whilst in sarcoids, the fibres appear to be of uniform development, being either all immature or all mature with a tendency for fibres over large areas of the tumour to run in 2 directions only.

Ragland *et al.* (1970), however, are of the opinion that the dermal component of equine sarcoids consists mostly of immature fibroblasts lacking any distinctive histological pattern, but in certain areas they may be arranged in a whorled pattern resembling neurofibromas or, less commonly, in a herring-bone pattern resembling fibrosarcomas. Jackson (1936) also described the fibroblasts in sarcoids as running in all directions. He stated that the degree of collagen deposition in equine sarcoids varies from immature, resembling fibrosarcomas, to mature, having the appearance of fibromas. According to him, in the initial stage of development of equine sarcoids, the epithelial component is very prominent but, as the tumour grows and expands, the dermal component becomes more prominent and may cause ulceration and disappearance of the epithelium, so that the biphasic nature of such a sarcoid is no longer present.

The author has noted that in sarcoids where the epithelial component, due to ulceration, is no longer present, the fibroblasts of the dermal portion form different patterns in different areas of the tumour. These fibroblasts were arranged either in an irregular or regular fashion (resembling fibrosarcomas) or formed whorls (resembling neurofibromas). Whorled areas were almost invariably present in one or other area of the sarcoid.

From the available literature it would seem, therefore, that it can sometimes be difficult to differentiate sarcoids, fibromas and fibrosarcomas microscopically. This would account for the conflicting incidence of fibromas and sarcoids in the different surveys conducted in various countries.

The head, and particularly the ear, followed by the trunk and the limbs, were the commonest site of origin for sarcoids in the series. Jackson (1936) reported the predilection sites for equine sarcoids as the lower portions of the limbs, especially the cannon region, the head, particularly the eyelids and lips, and the prepuce. Both he and Sundberg *et al.* (1974) suggested that these predilection sites point to a viral aetiological agent similar to that for papillomas in other domestic animals. Lancaster, Olson & Meinke (1977) have shown that DNA from spontaneous sarcoids hybridizes to bovine papilloma virus DNA. Furthermore, the development of sarcoid-like tumours has been induced via inoculation of the bovine papilloma virus, suggesting a possible involvement of the latter in the aetiology of sarcoids (Lancaster *et al.*, 1977). Apart from the above-mentioned sites, sarcoids have also been reported on the neck, shoulder, thorax, abdomen and castration sites (Strafuss *et al.*, 1973; Sundberg *et al.*, 1974), but it would appear that the head, limbs and abdomen are the principal sites of origin for this tumour. In contrast to the findings reported in this survey, Sundberg *et al.* (1974) and Jackson (1936) reported the eyelids to be the commonest site for sarcoids of the head. Sarcoids, arising from multiple sites, have been reported to be relatively common (Ragland *et al.*, 1970), but in this survey only 2 out of 58 cases were of a multiple nature.

In this survey, squamous cell carcinomas with 23,5% of the total neoplasms were the second most frequent type of neoplasm recorded. Similar incidence have been reported for this tumour in other countries (Head, 1953; Damodaran & Ramachandran, 1975; Strafuss, 1976; Sundberg *et al.*, 1977).

Fifty per cent of the squamous cell carcinomas involved the eye, especially the eyelids and nictitating membrane, followed by the prepuce and/or penis, the skin, vagina or vulva and the larynx. Surveys conducted in various countries revealed similar predilection sites for this tumour, although not always in the same order as above. In the USA, the eye has also been reported to be the primary site for squamous cell carcinomas, accounting for 50–65% of these neoplasms [Runnells & Benbrook (1942); Sundberg *et al.*, (1975); Lavach & Severin (1977)]. Strafuss (1976), however, found the prepuce and penis (44,8% of the total), to be the most commonly affected site, followed by the eye. Runnells & Benbrook (1942) and Sundberg *et al.* (1975) reported the penis and prepuce as the second site of preference. Both Sundberg *et al.* (1975) and Strafuss (1976) reported that the vulva and clitoris were the third most commonly affected site. In the United Kingdom, Head (1953) reported the eye as the primary site, followed by the skin and thereafter by the penis, whilst Baker & Leyland (1975) reported an equal incidence on the eye and penis, followed by the clitoris. In India, Damodaran & Ramachandran (1975) found the skin to be the primary site, followed by the penis and, lastly, the eye and adnexa.

In the majority of countries where surveys of tumours in Equidae have been conducted the eye seems to be the most common site for squamous cell carcinomas. In cattle, viral particles resembling papilloma viruses were seen with the electron microscope in pre-cancerous lesions of squamous cell carcinoma of the eyes (Ford, Jennings, Spradbrow & Francis, 1982). They suggested a multiple aetiology for the development of ocular squamous cell carcinoma in cattle, involving the papilloma virus and prolonged exposure to sunlight. If a similar situation exists in Equidae, this could explain why the eye accounts for such a high proportion of the squamous cell carcinomas of the horse.

The penis and prepuce is also a common site for squamous cell carcinomas, being either the most frequent or 2nd most frequent site for this tumour. Smegma has been suggested as playing a role in the development of squamous cell carcinoma of the penis or prepuce (Moulton, 1978). Plaut & Kohn-Speyer (1947), using equine smegma, were able to induce the development of papillomas, squamous cell carcinomas or fibrosarcomas experimentally at the inoculation site on the skin.

In this survey, connective tissue tumours accounted for 12,2% of the total tumours, 8,2% being fibromas and 3,4% fibrosarcomas. Fibromas were the third commonest type of tumour and fibrosarcomas the sixth. Baker & Leyland (1975) reported fibromas to be the commonest neoplasm of Equidae. They stated that the fact that it could be difficult to differentiate between fibromas and sarcoids could possibly account for the high number of fibromas recorded by them.

Runnels & Benbrook (1941) reported that 72,4% of 156 connective tissue tumours were of fibrous tissue origin, 28% being fibromas and 72% fibrosarcomas. This is similar to the findings in this survey where 75,8% of the 58 neoplasms of mesodermal origin were of fibrous tissue origin, although 70% were fibromas and 30% fibrosarcomas.

Melanomas, the fourth commonest type of tumour in this survey, accounted for 8,0% of the total neoplasms. The 2 principal sites for this tumour were the skin (66,6%) and the eye (13,3%). In India, Damodaran & Ramachandran (1975) found melanomas to be the third commonest type of tumour in Equidae, accounting for 15,7% of a total of 70 tumours. They noted that all these tumours arose on the skin and that all occurred in grey horses. Mangrulkar (1944), in trying to explain why grey

horses are more prone to developing melanomas, stated that there is a continual steady turnover of melanin pigment in man and animals throughout their life span. In pigmented animals, the demand for melanin is kept up throughout their life, whilst in grey horses this demand decreases with advancing age. The fact that all the melanin pigment is not utilized could result in hyperplasia or neoplasia of the melanoblasts of the skin. Mangrulkar (1944) reported 9 melanomas in Equidae, 7 of which were in aged grey horses. Eight of them involved the skin. Both Mangrulkar (1944) and Damodaran & Ramachandran (1975) reported the tail region as the primary site for cutaneous melanomas in Equidae. Mangrulkar (1944) also reported that a relatively high proportion involved the perineum. In this series, the melanomas of the skin, for which the site or origin was determined, involved the perineum, back or groin.

Papillomas are a relatively common tumour of horses. Baker & Leyland (1975) and Sundberg *et al.* (1977) recorded them as being the third most frequently encountered neoplasm of Equidae, accounting respectively for 8,9% and 5,5% of the total. Damodaran & Ramachandran (1975), however, recorded only 1 papilloma amongst a series of 70 neoplasms. In this survey, papillomas constituted 4,5% of the total and were the fifth commonest type of tumour recorded. The majority of these papillomas arose on the skin (64,7%), 17,6% involved the penis, while the remainder occurred on the nictitating membrane or in the oral cavity. Sundberg *et al.* (1977) also reported that most of the papillomas in their series occurred on the skin or else on the penis or prepuce. Cook & Olson (1951) reported equine papillomas to be an infectious disease affecting mainly the skin of the nose and lips.

In a survey conducted in the United Kingdom, lymphosarcomas, the sixth most commonly encountered neoplasm, comprised 4,8% of the total (Baker & Leyland, 1975). However, in the USA, Sundberg *et al.* (1977) reported that they constituted only 1,3% of 236 tumours. In this survey, lymphosarcomas were the seventh most frequent type of tumour, although they accounted for only 3,0% of the 378 tumours recorded. Neufeld (1973), on reviewing lymphosarcomas in horses, reported that they are not a common neoplasm of this species. Tomlinson, Doster & Wright (1979) observed virus-like particles in a neonatal foal with lymphosarcoma which resembled the type C retroviruses which have been shown to be the cause of lymphosarcoma in other domestic species.

Hayes, Priester & Pendergrass (1975), when reporting on 28 nervous tissue tumours in horses, noted that they all involved the peripheral nerves. In this survey, 1,3% tumours arose from nervous tissue, 4 of which were neurofibromas.

From this survey it can be concluded that out of a wide variety of neoplasms which can occur in Equidae, sarcoids and squamous cell carcinomas are the commonest types encountered.

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