Morphology of a dicephalic cat

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Summary. A detailed anatomical study of a dicephalic iniodymic monosomic cat in conjunction with the morphogenetical implications of the observed anomalies is presented. The animal exhibited two heads joined at the level of an anomalous medial exoccipital bone. Two brains and two foramina magna were present. The vertebral column was single but the cranial cervical vertebrae (C2 to C5) had doubled bodies. Cervical rachischisis with myeloschisis were associated defects. Two nasopharyngeal and oropharyngeal cavities converged caudally into a single laryngopharynx. The esophagus, larynx and trachea were single. Duplication of the tongue and hyoid apparatus was present. Palatoschisis affected both oral cavities. Hypoplasia of the anatomical structures in the medial aspects of both heads was observed. Microphthalmia was also observed in both medial eyes. Comparative aspects of the morphology, causative agents, and mechanisms and anomalous morphogenesis of anterior duplications are reviewed and discussed.

Key words: Dicephalia - Anterior duplications - Congenital malformations - Conjoined twins - Cat

Introduction

Among the domestic animal species, cats appear to have the lowest risk of incidence of spontaneous congenital defects (Priester et al. 1970). In a review of the literature covering a period of a century, Pia (1971) recorded a total of 588 cases of feline congenital malformations of which 89 cases were duplications. Anatomical duplications appear more commonly to involve the cranial parts of the body in the sheep (Dennis 1975). In most other animal species and in man, it has generally been considered that duplications affect more frequently the cranial portions of the body (Lesbre 1927; Arthur 1956; Duhamel 1966; Roberts 1971; Herring and Rowlett 1981). However, this appears not to be the case in the cat (Saperstein et al. 1976). In fact, from 89 feline conjoined twins, Pia (1971) found 53 caudal symmetrical duplications, 29 cranial symmetrical duplications and 7 asymmetrical double monsters, diprosopia being the most frequently reported anterior duplication.

True monosomic dicephalic conjoined twins appear to be rare in mammals (Schwalbe 1907; Lesbre 1927; Duhamel 1966; Szabo 1989). After an extensive review of the medical and veterinary literature, very few similar cases to that described here have been found. Detailed anatomical studies of congenital duplications are rare in the veterinary literature. In general, only descriptions of external features or minimal dissections have occasionally been made. Anatomical descriptions of these malformations can only provide some indications of possible etiologies. However, integration of morphology with underlying developmental processes could throw more light on the anomalous morphogenesis of these malformations. In this article a detailed morphological study of a dicephalic monosomic iniodymic cat is reported and comparative morphological aspects of anterior duplications, possible causative agents, and mechanisms and anomalous morphogenetical processes supposedly involved in these anomalies are reviewed and discussed.

Material and methods

A dicephalic mongrel male cat was presented to our laboratory. Owing to clinically confirmed fetal dystocia, the cat was delivered stillborn by caesarean section. It was the only member of the litter. The previous clinical history of the primiparous dam revealed an uneventful pregnancy. A recent history of infectious or congenital disease was not detected in the ancestors of the parents and in the offspring of their direct and collateral relatives. The dicephalic animal was kept in a refrigerator until its reception at the laboratory. Attempts to perfuse the vascular system 4 days postpartum were unsuccessful due to already established intravascular coagulation. After fixation by immersion in 10% buffered formalin, the
muscles and salivary glands were embedded in paraffin, sectioned and stained with hematoxylin-eosin. For histological purposes, tissue samples from some anomalous muscles and salivary glands were embedded in paraffin, sectioned and stained with hematoxylin-eosin.

Results

External inspection, radiographs and necropsy revealed a full-term fetus exhibiting normal structures in the trunk, tail, and limbs. Internal organs, as corresponding to a male cat, were also normal. The animal presented two heads and a neck (Figs. 2, 3), malposition of the left head being evident. Both heads showed two eyes, two pinnae, a snout and a mouth, but they had the calvaria deformed so that the right calvarium was clearly vaulted and the left one was remarkably flattened. Cranial deformations probably resulted from the need to create a wedge-shaped cephalic end during dystocic parturition. There was a cervical spina bifida aperta, the spinal cord being necrotic and exposed through an extensive skin and vertebral defect. On removing the skin of the heads and neck, dissection revealed hypoplasia of the different anatomical structures in the medial aspect of both heads.

Muscular system

Owing to the cephalic duplication and the extensive cervicothoracic rachischisis, some of the dorsal muscles of the pectoral girdle had their cranial or cervical attachments modified. For the same reasons, the cervical epaxial musculature exhibited anomalous origins or insertions. Four sets of muscles of the face and external ear were present. Nevertheless, the facial muscles of the medial aspect of both heads were hypoplastic. Some masticatory, short hyoid and lingual muscles were largely modified. In particular, there were three digastric muscles, the two medial ones were hypoplastic (Fig. 1c). Both lateral digastric muscles formed a common asymmetrical triangular muscle lamina for both heads (Figs. 1a, 2). Again three mylohyoid muscles were present; the two medial mylohyoids formed anomalous muscle bands, one of them attached to the right lateral genihyoid muscle, and the other united both medial mandibular bodies (Fig. 1c). The lateral mylohyoid formed a common transversal muscle lamina interrupted by a median fibrous raphe and united the two lateral mandibular bodies (Fig. 1b).

The histological picture of both medial sets of digastric and mylohyoid muscles and of some medial facial muscles was characterized, first, by the presence of a reduced number of muscle fibers surrounded by increased amounts of intercellular and interfascicular connective tissue and, second, by a considerable variation in size of the muscle fibers, some eosinophilic smaller ones being intermingled with normal fibers, thus simultaneously revealing muscular hypoplasia and atrophy.

There were only two lateral genihyoid (Fig. 1c), hyoglossus (Fig. 1d) and genioglossus muscles each for the right or the left head (Fig. 1d). The long ventral hyoid muscles, sternohyoïd and thyrohyoid, were normal. Finally, the ventral muscles of the cervical vertebral column, lateral and ventral rectus capitis and longus capitis, exhibited anomalous cranial attachments, each right or left fellow attaching only to the lateral side of basicranium of the right or left head, respectively. Both longus colli muscles originated in the axis instead of in the atlas.

Saliary glands and lymph nodes

The lateral parotid, mandibular, sublingual, zygomatic, molar, and buccal salivary glands of both heads were normal in shape, size and position; however, except for the medial parotid glands, their medial counterparts were slightly reduced in size. The medial parotid glands were fused to form a common glandular mass, but they exhibited independent excretory ducts for each head (Fig. 3); furthermore, a portion of this salivary gland, forming an accessory group of lobules, appeared at a distant dorsocaudal location between both heads, covered by intermingling muscle bundles (probably remnants of the medial parotidoauricular muscles) and showing a distinct glandular duct running ventrocranially to rejoin the excretory duct system of the common parotid glandular mass. Comparative histological analysis of the medial parotid glandular mass and of the abovementioned accessory group of lobules revealed that both of them had a similar structure. This was characterized by the existence of a predominant number of serous adenomeres and a few, unevenly distributed, mucous adenomeres, a structure typical of the feline parotid salivary gland.

The two sets of lateral mandibular lymph nodes were normal (Fig. 2). Two large lymph nodes, one of them located at the midline on the unpaired supernumerary jugular vein, and the other one related to the caudal aspect of the right medial superficial temporal vein of the left head, could be considered as their medial (mandibular lymph node) counterparts. The medial parotid