



## Gross Anatomical Studies on The Nasal Cavity of The Ostrich

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### ABSTRACT

The aim of the present study is to analyse the anatomical structure of the nasal cavity of ostrich (*Struthio camelus*). Twelve heads of adult ostriches of both sex were used. The anatomical description were one by using of normal anatomical dissection of the samples and making several transverse and sagittal sections through the nasal cavity. In addition computed tomography (CT) images were taken to whole head for more investigation and correlate the results of CT scan with that of anatomical sections. The obtained results showed that the nostrils of ostrich are unique as they had nither operculum at entrance nor fearhers. The nasal conchae were observed with will developed middle one which also showed more complex scroll in CT images. Nasal gland and infraorbital sinus; related to the nasal cavity also described in this study. The obtained result discussed with previous literatures to gave a reliable explanation to the anatomical structure which help to understand disease and possible treatments of the upper respiratory tract in ostrich.

**Keywords:** Ostrich, Nasal cavity, Computed tomography, Infraorbital sinus, Nasal concha

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### 1. INTRODUCTION

Recently, ostrich farming was improving greatly these years, and research into ostrich anatomy was also picking up. Ostrich belongs to family *Struthioidae* genus *Struthio*. The ostrich is unique in that it has two toes. It is of high economic value, as its meat is tender, delicious and highly nutritious, and its leather is flexible, permeable and highly durable, making it one of the highest grade leathers as well as high quality of feathers (Horbańczuk 1997; Mushi et al., 1998) and reindeer skin (Wang et al., 2001). The nostrils of the bird, which lead into the nasal cavity, may have a flap of horn to protect them, known as the operculum. The nasal cavity of the bird are interconnecting via a slit in the hard palate called the choana. The nasal cavity extends from the nostrils to the choana (McLelland, 1990). In most avian species, there are three conchae with broad variations in forms; the rostral, middle, and

caudal nasal conchae, implying homology to those of the mammals and other vertebrates (Bang, 1971; Baumel et al., 1993; Nickle et al., 1977). There is also an accessory concha; the septal nasal concha, which is very unique to Petrels (Bang, 1971). Three nasal conchae estimated in the domestic birds. However, in some cases one of them might be missed, for example the rostral nasal concha sometimes absent in *Sulidae* (Bang, 1971) and quail (King and McLelland, 1984). The middle nasal concha absent in *Phalacrocoracids* (Bang and Wenzel, 1985), and the caudal nasal concha in some taxa including *Collocalia* and *Psittacus* (Bang, 1971; Pohlmeier and Kummerfeld, 1989). Nowadays, increasing usage of different avian species rather than domestic chicken as models for biological research leads the anatomists to focus their studies on the morphology of these species

(Baumel et al. 1993; Dyce et al., 1996). Functionally, the conchae are more important, being the physiological players that increase the available surface area for respired air to pass over, allowing them to function in countercurrent heat exchange as well as odorant analysis. The functions of conchae vary depending on location in the nasal passage and what epithelial layers they support (Bourke et al., 2014)

In ostrich, the physiological function and mode of adaptation attracts many authors for studying the different components of the nasal cavity). Furthermore, the thermoregulatory function is an important process for ostrich through heating the passed air into the nasal passage and helping in the osmoregulatory function of the nasal gland (Skadhauge et al., 1984). Few data are recorded on the anatomy of the nasal cavity on this bird so this study is a trial to give the possible anatomical and information about the normal structures of the nasal cavity of ostrich. Moreover, no reports about the use of CT scan in this bird till now, this maybe first one correlate the structure of the nasal cavity of ostrich with the CT images.

## 2. MATERIALS AND METHODS

The current work was carried out on twelve specimens of adult apparently healthy ostriches of both sex. The birds were obtained from the slaughter house of Lion village, Beheira Governorate, Egypt. nine heads were dissected and sectioned sagittally and transversely in a rostro-caudal sequence to explain the morphological structure of the nasal cavity. The obtained results were photographed using Sony® digital camera 12.1 mp, 4x.

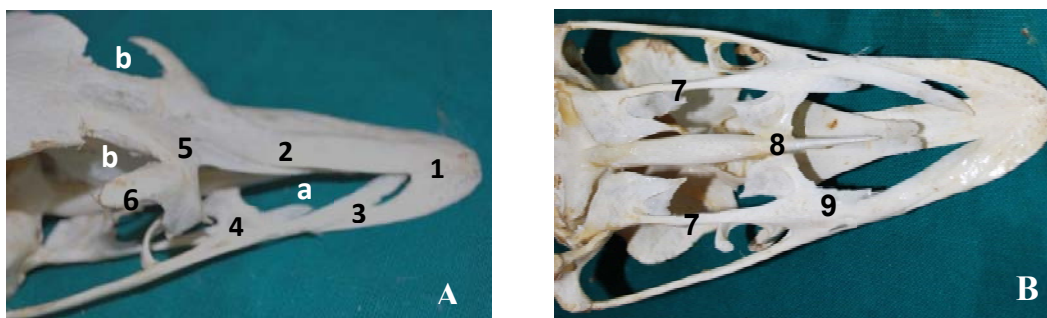
Fig. 1: A photomicrograph of adult ostrich head (dorsolateral view) showing: 1-culmen 2-rostral nasal concha exposed from the nostril, 3- infraorbital sinus

Three specimens were used to study the Computed tomographic features of the nasal cavity. The dissected samples were photographed and images were processed on the computer. The heads were underwent consecutive CT scan using CT scanner [TOSHIBA 600HQ, third-generation equip TCT, Japan] at Minia University Hospital, El-Minia, Egypt. The acquisition settings were 120 kv, 100 mAs and 0.9 mm slices of thickness. The official nomenclature used in this study was adopted according to (Nomina Anatomica Avium, 1993).

## 3. RESULTS

The nostrils (external naris) of examined birds were oval, longitudinally arranged and face dorsolaterally, situated in the dorsum of the maxillary rostrum about the end of its rostral third without operculum at the entrance of the external naris, no feathers found also around the nostrils, the two nostrils separated by culmen, which is a raised quadriangular elevation formed by the frontal process of premaxilla with the covering skin. It forms the medial border of the nostrils. the rostral nasal concha could be seen from outside (Fig. 1). The nasal cavity (Cavum nasi) is a cone shape cavity extended from the nostrils to the choanae with; its wider part caudally and apex rostrally. The nasal cavity supported by premaxilla, maxilla, nasal, vomer, lacrimal and palatine bones (Fig. 2, A&B). The nasal cavity completely divided with the nasal septum longitudinally into left and right halves. The nasal septum was partially membranous and partially cartilaginous in the rostral part and bony in its caudal part.





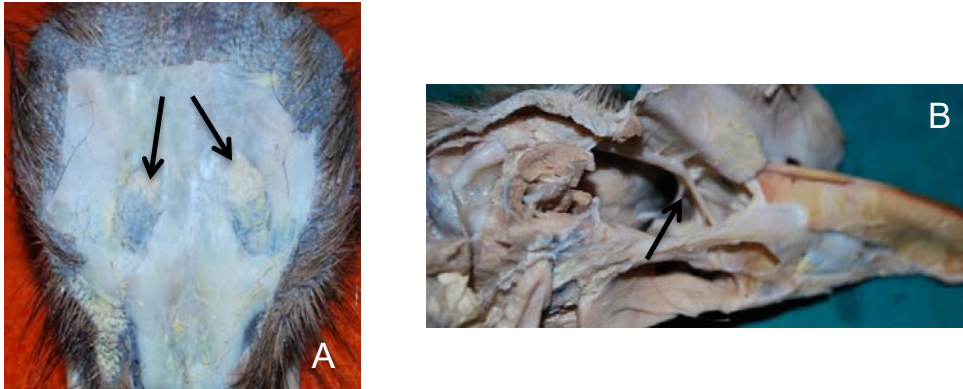
**Fig. 2 :**(A&B): A-Dorolateral view adult ostrich skull showing: 1- Os premaxillare, 2- Proc. frontalis of 1, 3- Proc. Maxillare of 1, 4- Os maxillare, 5- Os nasale, 6- os lacrimale 4- Os prefrontale, a osseous aperture of nostril, b- bilateral area in which nasal gland lodged. B- Ventral view showing: 7- Os palatinum, 8- Vomer, 9- Os maxillare

There were three nasal conchae observed in the ostrich, namely, rostral, middle and caudal nasal conchae. The rostral nasal concha, situated in the rostral part of the nasal cavity and extended caudally to its middle third. It had dorsal and ventral recesses. In transverse section, it was T-shaped projected from the lateral wall of the nasal cavity (Fig. 4,A), and extended caudally ventral to the rostral part of middle nasal concha leaving middle nasal meatus or interconchal meatus because it located between the rostral and middle conchae. At the caudal end of this concha the free portion attached to the floor of the nasal cavity and the nasal septum by a fold of mucous membrane. Hence, it obliterate the nasal meatus between the rostral concha and floor of the nasal cavity so the air passed to the common nasal meatus between the nasal septum and nasal conchae. The second concha, the middle nasal concha was bigger

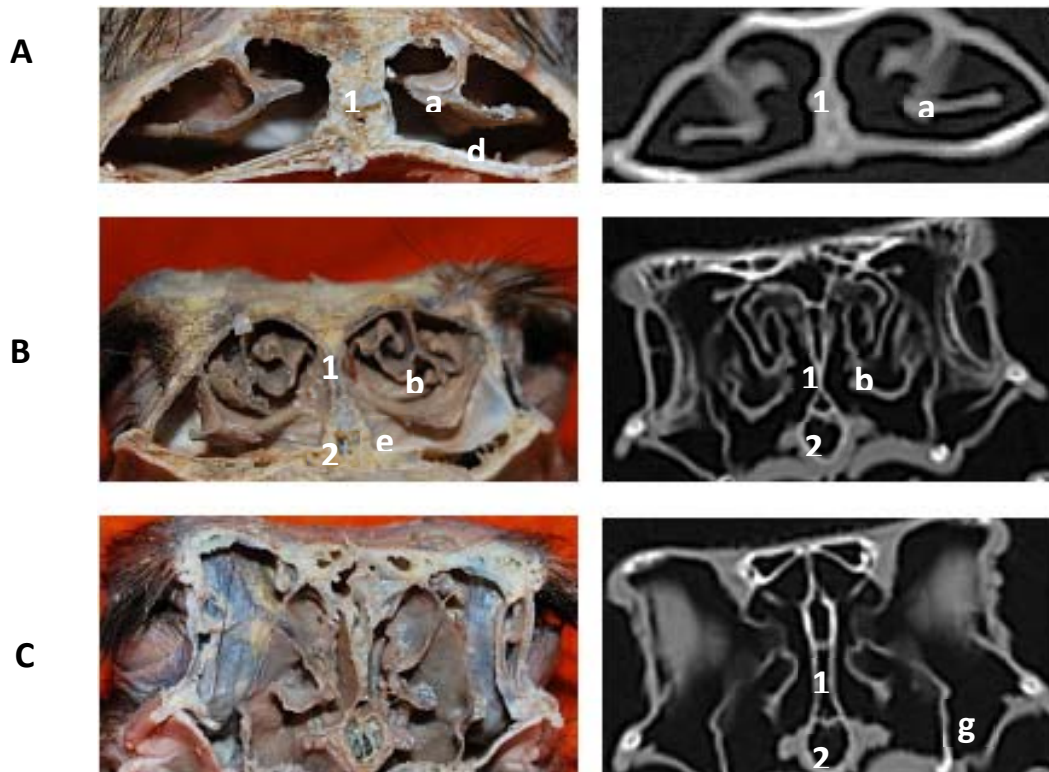
than aforementioned one and dorsocaudally to it and coiled with bulla like (Fig. 4,B). It observed as an elongated structure situated between the dorsal nasal meatus dorsally middle nasal meatus ventrally at the middle of the nasal cavity then it run between the dorsal nasal meatus and ventral nasal meatus in the middle two third of the nasal cavity. In a median section of the nasal cavity after removal of the nasal septum at medial aspect of the middle concha, a shelf of small turbinate bone, connect between the dorsal and ventral wall of the nasal cavity. The caudal nasal concha is the smallest one with triangular shape and occupied the nasal fundus. In transverse section it appeared scroll shaped. The middle concha attached firmly to the third concha and continued caudally with it; the caudal nasal concha, so it was very difficult to distinguish between them.



**Fig. 3: (A & B)** Medial view of sagittal section in adult ostrich head and CT image showing: a- rostral nasal concha, b- middle nasal conch, c- caudal nasal concha, d- orbit, 1- dorsal nasal meatus, 2- ventral nasal meatus, 3- the choanal opening, 4- infraorbital sinus



**Fig.4:** (A& B), A: Dorsal view of adult ostrich head after reflection of the skin showing paired nasal glands (arrows)., In B: medial view of longitudinally sectioned and dissected nasal cavity of adult ostrich showing the duct of the left nasal gland.



**Fig. 5:** Transverse section through the the nasal cavity of adult ostrich compared with CT image of the same region. **(A)** at the level of rostral nasal concha, **(B)** at the level of middle nasal concha, and **(C)** at the level of caudal nasal concha. Showing 1- Septum nasi, 2- Vomer, a- rostral nasal concha, b- middle nasal concha, c- caudal nasal concha, d- ventral nasal meatus, e- mucousal fold attach the free caudal end of the rostral concha to the the floor and septum of nasal cavity, f- the eye ball, g- infraorbital sinus

The caudal nasal concha small triangular in shape and occupy the nasal fundus and connected with the it by mucousal fold caudally. The caudal concha less scrolling and more ossification than the middle one. The ventral nasal meatus at the caudal third of the nasal cavity connected with the the oropharyngeal cavity through the choanae and infraorbital sinus laterally. The choanae which are two oblique slits in the palate separated from each other by a low ridge of mucous membrane. Together the two choanae form a triangular opening in the palate with the apex directed rostrally. The infraorbital sinus in ostrich began rostral to the medial canthus of the eye, about the middle of the maxillary rostrum and extended caudally ventral to the eye and terminated caudodorsal to the eye ball. Moreover, it was observed a pair of bilateral subcutaneous small oval, nasal gland dorsomedial to the medial canthus of the eye and enclosed by the lacrimal bone, their duct extended ventrally and rostrally in the caudal nasal cavity to open at the caudal end of rostral nasal concha. Computed tomography (CT) scan on the head of the adult ostrich gave a detailed information of the nasal conchae, the shape of each one, nasal meatuses, infraorbital sinus and its connection with nasal meatus as well as the choanal opening. The obtained results of CT images showed in (Fig. 1 &5) which correlated with the gross anatomical description of the nasal cavity.

#### 4. DISCUSSION

The present study revealed that the nostrils had an oval shape with no operculum; a cornified fold which found in most of domestic birds (King and McLelland, 1984; Nikkle et al., 1977). The size of the nostrils was reduced by the nasal operculum in domestic birds (Fitzgerald, 1970; Nickel et al., 1977 and Dyce et al., 1996) and in Japanese quail (Aysun et al., 2007). The same finding were found in hooded crow by (Hassan, 2012) there were no nasal

operculum in but the nostrils were covered completely by a tuft of fine feathers. The median column making up the dorsal border of the external nares; formed by processes of the nasal and premaxillary bones (Baumel and Witmer,1993). Moreover, th nasal cavity was completely separated to right and left halves, but the previous studies stated that the nasal cavity cavity in duck and Wanxi white geese was connected because it had a long and narrow opening in the nasal septum in duck and Wanxi white geese (Mushi et al.,1998). Baumel et al., (1993) stated that the nasal septum may be supported in part by the vomer, maxilla, and ectethmoid bones. The rostral part of the nasal septum vary in the extent that they ossify in different birds, usually remaining more or less cartilaginous. These structures characteristically ossify extensively in, for example, some parrots, birds of prey, herons and ibis. This agree with the current finding of being appeared membranocartilaginous rostrally and bony caudally. Concerning the nasal conchae, the results classified the nasal conchae in ostrich as rostral, middle and caudal and hence agree with that mentioned by (Jin et al., 2008) in ostrich chicks. Moreover,as observed in the domestic chicken (Bang, 1971; Bang and Wenzel, 1985), the middle nasal concha occupies a large part of the nasal cavity of all birds. However, species differences are observed in the internal structure of the middle concha. The structure of the middle is more complicated in avian species with a well-developed olfactory ability such as the brown kiwi. However, in birds with a common level of olfaction, such as the domestic chicken, the middle concha is simply a “scrolled” structure (Bang and Wenzel, 1985). Therefore, the structure of the middle concha in ostrich that observed either by gross anatomical examination or by CT recommend that ostrich had an olfactory ability in a higher level than that of chicken. Luo (1983) described that the nasal glands are confined and long in fowls, its frontal half-part is aslant situated on the lateral wall

of the nasal cavity and over the basal posterior nasal conchae outwards, its posterior half is parallel with the anterior border of the frontal bone over the back of eyeball, and are buried in the connective tissue at these places. Similarly, found in ostrich. comparing reported by Skadhauge, (1981) in marine birds and domestic duck having a relative mass 20-fold higher than in the ostrich. The septal nasal concha, which is a very unique structure of Petrels (Bang, 1971), was not observed in ostrich that also agree with mentioned by (Hassan, 2012) hooded crow and (Aysun et al., 2007) in Japanese quail. The infraorbital sinus was a triangular paranasal cavity situated beneath the surrounding the orbit rostrocaudally and ventrally and in the lateral region of the maxillary rostrum. CT scan of the nasal cavity of ostrich provided us with an excellent results tht could help not only to study th anatom of this species but also in diagnosis and possible treatment of upper respiratory tract affections.

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