# Supplemental information

Appendix 1: Function of quadrate sub-entities.

Appendix 2: Quadrate sub-units terminology.

References

## Appendix 1. Function of quadrate sub-entities.

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| **Anatomical component** | **Nature** | **Anatomical sub-entity** | **Function** | **Theropod clades** | **Publication** |
| Quadrate diverticulum | Tympanic sinus, mandibular arch pneumatic system | Anterior, posterior, medial, ventral and dorsal pneumatic foramina | Auditory function? | All Theropoda | (Witmer 1990; Kundrát and Janáček 2007; Tahara and Larsson 2011) |
| Siphoneal diverticulum | Tympanic sinus, mandibular arch pneumatic system | Ventral pneumatic foramina? | Auditory function? | Allosauroidea?  Tyrannosauroidea? | (Tahara and Larsson 2011) |
| Dorsal tympanic diverticulum | Tympanic sinus | Quadrate head, separated into otic and squamosal capitula | Auditory function | Neognathae | (Witmer 1990) |
| Musculus Protractor Pterygoideus (MPPt) | Orbitotemporal muscle | Medial surface of the pterygoid flange | Insertion for the MPPt | Avian and non-avian? Theropoda | (Holliday 2009) |
| Musculus Adductor Mandibulae Externus Medialis (MAMEM) + Musculus Adductor Mandibulae Externus Superficialis (MAMES) | Temporal  muscle | Posteromedial portion of the quadrate head | Origin for the MAMEM + MAMES | Avian and non-avian? Theropoda | (Sakamoto 2008) |
| Musculus Adductor Mandibulae  Posterior (MAMP) | Palatal  muscle | Lateral surface of the pterygoid flange | Origin for the MAMP | All Theropoda | (Molnar 1998; Sakamoto 2008; Holliday 2009) |
| Musculus Pseudotemporalis Profundus (MPsTP) | Palatal  muscle | Anterior surface of the quadrate head | Origin for the MPsTP | Neornithes | (Holliday and Witmer 2008; Sakamoto 2008; Holliday 2009) |
| Otic joint | Synovial joint | Quadrate head | Articulation with squamosal | All Theropoda | (Holliday and Witmer 2008) |
| Articular process of quadrate | Synovial joint | Mandibular condyles | Articulation with mandible | All Theropoda | (Holliday and Witmer 2008) |
| Intercondylar sulcus | Synovial joint | Groove between ectocondyle and entocondyle | Ventral or ventrolateral displacement of mandible rami | All Theropoda | (Molnar 1991; Bakker 1998; Hendrickx and Buffetaut 2008) |
| Branches of maxillomandibular vessels | Neurovascular bundle | Quadrate foramen | Neurovasculature transmission between the occiput and adductor chamber | Some Theropoda | (Sampson and Witmer 2007) |

## Appendix 2. Terminology of nonavian theropod quadrate sub-unit by authors.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Source** | **Referred taxa** | **Quadrate shaft** | **Quadrate ridge** | **Pterygoid flange** | **Lateral process** | **Quadrate foramen** | **Quadrate head** | **Ento-/Ectocondyles** |
| Sereno and Novas 1994 | *Herrerasaurus* | Shaft | / | Pterygoid ramus | / | Quadrate foramen | Head | Distal condyles |
| Colbert 1989 | *Coelophysis* | Ascending process | / | Quadrate flange | Smaller surface/wing | / | Upper extremity | Quadrate condyle |
| Welles 1984 | *Dilophosaurus* | Shaft | Column | Pterygoid wing | Dorsal wing | Quadrate foramen | Head | Ento/Ectocondyles |
| Smith et al. 2007 | *Cryolophosaurus* | Body | Rounded ridge | / | / | Paraquadrate fenestra | Dorsal head | Medial/Lateral condyles |
| Gilmore 1920 | *Ceratosaurus/*  *Allosaurus* | / | / | Sheet/projection | / | Quadrate foramen | / | articular surfaces |
| Madsen and Welles 2000 | *Ceratosaurus* | Pillar | / | Pterygoid wing | Anterolateral wing | Quadrate foramen | Head | Ento/Ectocondyles |
| Carrano et al. 2011 | *Masiakasaurus* | Shaft/body | / | Pterygoid articular flange | / | Foramen | / | Medial/Lateral condyles |
| Coria and Salgado 1998 | *Ilokelesia* | / | / | Medial process | Lateral lamina/process | / | Squamosal condyle | Medial/Lateral condyles |
| Bonaparte et al. 1990 | *Carnotaurus* | / | / | Anteromedial projection | / | / | / | Lower condyles |
| Sampson and Witmer 2007 | *Majungasaurus* | Shaft | / | Pterygoid ramus | Lateral/quadratojugal ramus | Paraquadrate foramen | Head | Medial/Lateral condyles |
| Sadleir et al. 2008 | *Eustreptospondylus* | Shaft | / | Pterygoid ala | / | / | Head | Medial/Lateral condyles |
| Britt 1991 | *Torvosaurus* | Shaft | / | Pterygoid blade | / | Quadrate foramen | Head | Medial/Lateral condyles |
| Charig and Milner 1997 | *Baryonyx* | Shaft | / | Pterygoid flange | / | Quadrate foramen | Head | Quadrate condyle |
| Madsen 1976 | *Allosaurus* | Shaft/body | / | Contact with the pterygoid | / | Quadrate foramen | Head | Condyles |
| Sereno et al. 2008 | *Aerosteon* | Shaft | / | Pterygoid process | / | Quadrate foramen | Head | Distal condyles |
| Currie 2006 | *Sinraptor* | Column | / | Pterygoid flange/ala | Wing-like process | Quadratic foramen | Quadrate cotyle | Medial/Lateral condyles |
| Currie and Carpenter 2000 | *Acrocanthosaurus* | / | / | / | / | Quadrate foramen | Head | Condyles |
| Eddy and Clarke 2011 | *Acrocanthosaurus* | / | / | Pterygoid wing/contact | / | Quadrate foramen/fenestra | Quadrate cotylus | Medial/Lateral condyles |
| Brusatte et al. 2010 | *Shaochilong* | Shaft | / | Quadrate flange | / | Quadrate foramen | Quadrate cotylus/head | Medial/Lateral condyles |
| Coria and Currie 2006 | *Mapusaurus* | / | / | Pterygoid flange | / | Quadratic foramen | Quadrate cotyle | Mandibular articulation |
| Choiniere et al. 2014*b* | *Aorun zhaoi* | Shaft, Quadrate shaft | / | Pterygoid ramus | / | Quadrate foramen | Quadrate head | Quadrate condyles |
| Rauhut et al. 2010 | *Proceratosaurus* | / | Columnar ridge | Pterygoid flange | / | Quadrate foramen | Head | Medial/Lateral condyles |
| Li et al. 2010 | *Xiongguanlong* | Shaft | / | Quadrate wing | / | Quadrate foramen | / | Medial/Lateral condyles |
| Brusatte et al. 2012 | *Alioramus* | Shaft | Robust ridge | Quadrate flange | / | Quadrate foramen | Head | Medial/Lateral condyles |
| Carr 1996 | *Albertosaurus* | Quadrate body | Ridge | Pterygoid flange/process | / | Quadrate fenestra | Quadrate cotyle | Medial/Lateral condyles |
| Currie 2003 | *Albertosaurus/*  *Daspletosaurus* | / | / | Pterygoid ala | / | Quadrate fenestra | Quadrate cotylus | Mandibular condyles |
| Molnar 1991 | *Tyrannosaurus* | Vertical bar | / | Pterygoid process | / | Quadrate foramen | Hemispherical surface | Quadrate condyle |
| Brochu 2003 | *Tyrannosaurus* | / | / | Pterygoidal flange | / | Quadrate foramen | Head | Medial/Lateral hemicondyles |
| Dal Sasso and Maganuco 2011 | *Scipionyx samniticus* | / | / | Pterygoid ala | / | Paraquadrate foramen | Quadrate head | Medial/Lateral condyles |
| Choiniere et al. 2014*a* | *Haplocheirus sollers* | Quadrate shaft | Ridge, pillar | Pterygoid ramus | / | Quadrate foramen | Quadrate head | Medial/Lateral condyles |
| Kobayashi and Lü 2003 | *Sinornithomimus* | / | / | Pterygoid wing | / | Paraquadratic foramen | / | Medial/Lateral condyles |
| Kobayashi and Barsbold 2005 | *Garudimimus* | / | / | Pterygoid wing | / | Paraquadratic foramen | / | Mandibular condyles |
| Zanno 2010 | *Falcarius* | / | / | Pterygoid process/flange/wing | / | Quadrate foramen | Head/Squamosal capitulum | Medial/Lateral condyles |
| Clark et al. 1994 | *Erlikosaurus* | Body | / | Orbital process | / | Quadrate foramen | Dorsal process | Mandibular process |
| Lautenschlager et al. 2014 | *Erlikosaurus* | Main body | Ridge | Pterygoid flange | Spike-like projection | Paraquadrate foramen | Quadrate head | Mandibular articulation (Medial/Lateral condyles) |
| Maryańska and Osmólska 1997 | *Oviraptoridae* | Shaft | / | Pterygoid ramus | / | Quadrate foramen | Otic process | Medial/Lateral condyles |
| Choiniere et al. 2010 | *Zuolong* | Shaft | Ridge | Pterygoid ramus | / | Quadrate foramen | Dorsal condyle | Medial/Lateral condyles |
| Burnham 2004 | *Bambiraptor* | / | / | / | / | / | Otic process | Medial/Lateral condyles |
| Norell et al. 2006 | *Tsaagan* | Shaft | / | Anterior/pterygoid flange | Squamosal ramus | Quadrate foramen | Dorsal articulation | Articular ramus |
| Colbert and Russell 1969 | *Dromaeosaurus* | Shaft |  | Pterygoid flange/wing | / | Quadrate foramen | Head | Medial/Lateral condyles |
| Currie 1995 | *Dromaeosaurus* | / |  | Anterodorsal lamina | / | Quadrate fenestra | Head | / |
| Norell and Hwang 2004 | *Saurornithoides* | Shaft |  | Pterygoid flange | / | / | / | Medial/Lateral condyles |
| Norell et al. 2009 | *Zanabazar* | Shaft |  | / | / | / | Head | / |

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