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The effect of extracapsular injuries on growth and development of the mandible condyle: an experimental study in growing dogs

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Objective. To investigate the effects of condylar extracapsular injuries on the development of the mandibular condyle and try to find a way to treat condylar hyperplasia by electively using such injuries to restrict the overdeveloped mandibular condyle.
Study Design. Sixty 6-month-old beagle puppies were divided randomly into five groups: blank control; unilateral fracture to the condylar neck; unilateral fracture to the condylar neck treated with rigid internal fixation; unilateral periosteum injury; unilateral decortication of the condylar neck. Computed tomography, ^{99} ^{m}Tc single-photon emission computed tomography, and tetracycline–calcein double-labeling were performed after surgery. The puppies were sacrificed 12 and 24 weeks after surgery. Morphologic analyses and examination of growth activity were done.
Results. Unilateral fracture of the condylar neck without fixation caused local morphologic changes during the early postoperative period, but compensatory growth of the condyle altered such changes after healing. The other types of injury failed to inhibit the growth of the condyle and the mandible, whereas functional deviation of the chin was found after unilateral fracture of the condylar neck with or without fixation.
Conclusions. The four types of extracapsular injury described here failed to inhibit the growth of the mandibular condyle and could not be selected as alternatives to treat condylar hyperplasia. (Oral Surg Oral Med Oral Pathol Oral Radiol 2016;■:e1-e15)

The "condylar process" is the process on the human mandible that ends in a condyle: the "mandibular condyle." Abnormal development of the mandibular condyle is one of the main reasons for dental–facial deformities with a high prevalence rate of morbidity, but its cause is not known. Condylar hyperplasia (CH) is a typical abnormality of condyle development, characterized by increased growth followed by progressive elongation and enlargement of the affected condyle (or even the whole mandibular ramus) without obvious pathologic change in the condyle.[1] Overdevelopment of the condyle and the mandible influences their aesthetic and functional aspects. The approach to therapy after condyle growth ceases is primarily surgery. However, for growing patients who can be diagnosed early, timely intervention may be favorable for delaying or preventing disease progression before severe deformity occurs. A high condylectomy is widely regarded as an effective surgical approach to correct CH during the growing stage. However, this approach is controversial because of damage to the intercapsular structure, which frequently results in ankylosis or disorders of the temporomandibular joint.[2]

Prevalence of mandibular injury in growing patients is high (55%)[3] and results from numerous school and athletic activities.[4] Among them, condylar injuries (intercapsular and extracapsular) are the most common types.[5] The mandibular condyle has long been known to be the "growth center" of the mandible. Growth and development of the condyle can last up to the end of puberty. Therefore, any type of condylar injury can restrict normal development of the mandible and cause facial asymmetry during the entire growing stage. For such patients, close reduction is recommended routinely. Open reduction and rigid internal fixation (ORIF), as a type of secondary injury to bone structure, is used only if a

Statement of Clinical Relevance

It is necessary to investigate the possible effects of condylar extracapsular injuries on the condyle and mandible in growing children and to find some experimental evidence for an early intervention approach to treat condylar hyperplasia.

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Table I. Landmarks of skull computed tomography and description

Name	Definition
Landmarks of central structure	
SS	Intersection point of skull sagittal suture and lambdoid suture
N	Nasion, most anterior point of the front nasal suture
ANS	Anterior nasal spine, tip of the anterior nasal spine
MAC	Mandibular alveolar point, tip of the alveolar ridge between bilateral mandibular central incisors
Po	Pogonion, most anterior point on the bony chin
Me	Menton, lowermost point on mandibular symphysis in the midline
Landmarks of mandible	
Go	Gonion, most posteroinferior point at the angle of the mandible
Landmarks of condyle	
Co	Condylion, the most superior point of condylar head
CHa	The most anterior point on midline of condylar head
CHp	The most posterior point on midline of condylar head
CHi	The innermost point of condylar head
CHo	The outermost point of condylar head
CNa	The most anterior point on midline of condylar neck
CNp	The most posterior point on midline of condylar neck
CNi	The innermost point of condylar neck
CNo	The outermost point of condylar neck
Reference plane	
SP	The median sagittal plane of skull (SS-N-ANS)
MSP	The median sagittal plane of mandible (MAC-Po-Me)
CHP	The horizontal plane of condylar base (CSa-CSp-CSo)

Table II. Measurement parameters of skull computed tomography

Name	Definition	Meaning
Morphology of mandible		
Co-Go	Distance between Co and Go	Height of mandible ram
Co-MAC	Distance between Co and MAC	Length of mandible body
Go-MAC	Distance between Go and MAC	Length of mandible body
Morphology of condyle		
Co-CHP	Distance from Co to plane CHP	Height of condyle
CHa-CHp	Distance between CHa and CHp	Length of condylar head
CHi-CHo	Distance between CHi and CHo	Width of condylar head
CNa-CNp	Distance between CNa and CNp	Length of condylar neck
CNi-CNo	Distance between CNi and CNo	Width of condylar neck
Symmetry of mandible		
Po-SP	Distance from Po to plane SP	Extent of mandibular deviation
Co-MSP	Distance from Co to plane MSP	Symmetry of bilateral condyle
Go-MSP	Distance from Go to plane MSP	Symmetry of bilateral mandibular angle

comminuted or severely displaced fracture has occurred.[5,6] All types of condylar injury (including RIF) carry the risk of growth inhibition, the mechanism of which is complex and unclear. Injuries to intercapsular structures can cause severe facial deformity and dysfunction of mandibular movement in children,[7] but if simple extracapsular injury to the condyle has occurred, the prognosis is not clear.

Here, we employed a method of extracapsular injury to the condyle that did not affect the intercapsular structures as an early intervention to inhibit overdevelopment of the condyle. We aimed to (1) investigate the effects of extracapsular injuries to the condyle on the growth of the condyle and the mandible in growing dogs and (2) provide experimental evidence for a new approach to treat CH.

MATERIALS AND METHODS

Animals and surgical procedures

The protocol was approved by the Ethics Committee of Laboratory Animal Center of the Forth Military Medical University, Shaanxi, PR China. Sixty 6-month-old healthy beagle puppies (in their growth period) were randomly divided into five groups (12 in each group): Group O: blank control group; Group A: unilateral condylar neck fracture; Group B: unilateral condylar neck fracture and reduced with rigid internal fixation (RIF); Group C: unilateral periosteum injury of condylar neck; and Group D: unilateral decortication of condylar neck. Each group was then divided into two subgroups (six in each subgroup): Subgroup *a* was sacrificed 12 weeks postoperatively and subgroup *b* was sacrificed 24 weeks postoperatively.

Surgical procedures were performed with the animals under general anesthesia (3% Phenobarbital Sodium; Sigma Chemical Co, St. Louis, MO). The right condyle of each animal was chosen as the operation side, and sham operation was done on the contralateral side. The condylar process was exposed after a temporo-preauricular incision and blunt dissection, and the following was carried out:

Group A: transverse fracture on the middle of condylar neck.
Group B: transverse fracture followed by reduction and internal fixation with a four-hole titanium plate and four 1.5-mm titanium screws.
Group C: Periosteum of condylar neck dissected and removed.
Group D: Cortical bone of outer surface of condylar neck removed with a depth of 1.5 mm.

For the sham operation side, which was taken as auto-control, the condylar process was exposed and then the wound was closed. All experimental animals were injected with penicillin (800,000 U/d, intramuscularly) 3 days postoperatively to prevent infection.