Unilateral loss of occlusal support during deciduous dentition and its consequences to the growing mandibular condyle.

Introduction

- Loss of supporting zones may lead to altered functional load of the condylar process of the mandible\(^1\) (C.m.).
- Alterations of the functional load may lead to changes of the shape and the structure of the growing C.m.\(^2,3\).
- The changes of the growth and structure of the growing C.m. are examined three-dimensionally.

Material and Methods

- The first molars of 8 eight-month-old micropigs are removed unilateral (Fig.3); experimental term: 4 months
- Ipsilateral: loaded condyle, here named C.m.\(\beta\)
- Contralateral: unloaded condyle, here C.m.\(^\gamma\)
- Preparation: undecalcified serial sagittal sections (Fig.2), microradiography, fluorescence microscopy (intravital polychrome sequence labeling), lightmicroscopy (Goldner)
- Vertical growth: measurement of the distance between the fluorescent band and articular surface (Fig.4)
- Ratio of the vertical growth of the unloaded condyle over the loaded condyle: Quotient \(q_g = C.m.\gamma / C.m.\beta\)
- Articular surface curve C: the vertical growth during the experimental period is part of a virtual radius \(r\): \(C = 1 / r\)
- Trabecular bone volume in relation to non-mineralized medullar space in \%: it is calculated by planimetry to acquire a measure for the spongy bone density
- Ratio of the trabecular bone volume of the unloaded over the loaded side: Quotient \(q_V = C.m.\gamma / C.m.\beta\)
- Ratio of the total amount of bone produced by the unloaded condyle over the loaded condyle: \(RTAB = q_g \times q_V\).

Results

**VERTICAL GROWTH AND ARTICULAR SURFACE CURVE**

- \(q_g = C.m.\gamma / C.m.\beta = 1.56\) (\(p=0.0029\)) (Difference C.m. minus C.m. circa 10.5 \(\mu\)m per day, Fig.5a)
- The average vertical growth of the unloaded side is about 1.56 times higher compared to the loaded side
- The average articular surface curve is less on the unloaded side than on the loaded side according to \(C = 1 / r\).
• \( g \) increases from dorsomedial with 1.33 to ventrolateral with 2.38 in line with axis a (p=0.0311) (Fig.5b)
  
  ① An additional ventrolateral flattening of the over all less curved unloaded condyle is found.

Fig. 5a: Condylar growth of C.m.Ý and C.m.ß per day [µm]
Fig.5b: Ratio of the vertical growth:
\[ q_g = \frac{\text{C.m.Ý}}{\text{C.m.ß}} \]

TRABECULAR BONE VOLUME

• C.m.ß: 48.65 vol%; C.m.Ý: 41.27 vol%; difference = 7.38 vol% (p=0.0018)
  ① The spongy bone density of the un-loaded side is lower. This difference is greatest ventral (p=0.001) (Fig.6a-c).

  ② Increased growth correlates to decreased spongy bone density.

  \[ q_V = \frac{\text{C.m.Ý}}{\text{C.m.ß}} = 0.85 \ (p=0.0014) \]

  • RTAB = \( q_g \times q_V \) = 1.33
  ① The total amount of bone added to the unloaded condyle is 1.33 times higher than on the loaded side. Thus, the effect of increased growth exceeds the effect of decreased trabecular bone volume.

Fig. 6a: Difference of the trabecular bone volume. C.m. minus C.m.
Fig. 6b,c: Microradiography, central sagittal section of the unloaded condyle (a, C.m.) and loaded Condyle (b, C.m.). Mandibular fossa (M.F.). C.m. shows a lower trabecular bone volume. (lines: 5mm)

LIGHTMICROSCOPIC EXAMINATION

• C.m.Ý with a higher thickness of the cartilage layer than C.m.ß(Fig. 7a,b)

• Defects of the condylar cartilage and subchondral bone (higher Frequency in C.m.ß), substitution by fibrous tissue, limited regeneration (Fig. 7c,d)

Fig. 7a,b: Central sagittal sections, Goldner stained, unloaded (a, C.m.Ý) and loaded Condyle (b, C.m.ß).
Bone (B), cartilage (C), fibrous tissue layer (F), discus (D), (lines: 50µm)

Fig. 7c: Central sagittal section, Goldner stained, bone (B), defect (D), regeneration (R), cartilage (C), (line: 100µm)

Fig. 7d: Central sagittal section, microradiography, defect (D), mandibular condyle (C.m.), mandibular fossa (M.F.), (line: 5mm)

Discussion and Conclusions

• The adaptive mechanisms of the growing mandibular condyle are not sufficient.

• The reestablishment of the occlusion by the advancing second dentition can lead to a stabilization of the articular imbalance.

• Non-physiological loss of occlusal support in juveniles may justify a temporary application of a splint.

Literature

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This Poster was submitted on 20.05.99 by Dr. Ingo Springer.
Unilateral Loss of Occlusal Support during Deciduous Dentition and its Consequences to the Growing Mandibular Condyle

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Introduction
- Loss of supporting bone may lead to abnormal functional load of the condyle process of the mandible (Cmj).
- Alterations of the functional load may lead to changes of the shape and the structure of the growing C mj.
- The changes of the growth and structure of the growing C mj are examined three-dimensionally.

Material and Methods
- The first molars of 8 right-handed M md subjects are removed unilaterally (Fig. 1), experimental group. 3 months old
- Unilateral loaded condyle, bone name C mj L
- Contralateral unloaded condyle, bone name C mj R
- Preparation unbuffered serial sagittal sections (Fig. 2), microtome
- Hematoxylin-eosin-staining, longitudinal sections (Fig. 2), microtome
- Vertebral growth measurement of the distance between the vertebral bone (bottom) and articular surface (Fig. 4)
- Ratio of the vertical growth of the unloaded condyle over the loaded condyle (quotient qr = C mj R / C mj L)
- Articular surface area C mj: the vertical growth during the experimental period is a part of a virtual index C mj = C mj R / C mj L
- Unloaded bone volume in relation to non-functionalized trabecular bone space in %, it is calculated by stereometry to acquire a measure for the spongiosa bone density
- Ratio of the trabecular bone volume of the unloaded over the loaded side (quotient qB = C mj R / C mj L)
- Area of the total amount of bone produced by the unloaded condyle over the loaded condyle RTAB = qB

Results
- Vertical growth and articular surface curve
  - q = C mj R / C mj L = 1.56 (p < 0.0001) (difference C mj R < C mj L)
  - Area C mj: C mj L 19.5 cm2/day (Fig. 4)
  - The average vertical growth of the unloaded side is about 1.56 times higher compared to the loaded side.
  - The average articular surface curve (less on the unloaded side than on the loaded side according to C mj R / C mj L)
  - q increases linearly denominated with 37.5% ventrolateral (27.5 cm2/day with respect to p < 0.0001) (Fig. 1)
  - An additional articular surface thinning of the over all less curved unloaded condyle is found.

Trabecular Bone Volume
- C mj R = 88.65 mm3, C mj L = 53.27 mm3, difference = 35.38 mm3 (p < 0.0001)
- The spongiosa bone density of the unloaded side is lower. This difference is greatest ventrolateral (p < 0.0001) (Fig. 6)
- Reduced growth rate to decreased spongiosa bone density.

Electrographic Examination
- C mj R = 0.98 mm, C mj L = 0.75 mm (p < 0.0001)
- The spongiosa bone density is decreased ventrolateral (p < 0.0001) (Fig. 6)
- The trabecular bone volume of the unloaded condyle is 1.53 times higher than on the loaded side. Thus, the effect of increased growth exceeds the effect of decreased trabecular bone volume.

Discussion
- The adaptive mechanisms of the growing mandibular condyle are not sufficient.
- The reestablishment of the occlusion by the advancing second dentition can lead to a stabilization of the articular surfaces.
- Neurophysiological loss of occlusal support in juveniles may justify a temporary application of a splint.