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Scenario Model Sc 121 Manual Muscle

Chewing also provoked a slight anterior-posterior shift of the observed stress concentrations when compared to gnawing, which resulted in significant stress concentrations at the mandibular symphysis (Figure). EK: Contributed to the development of the model, the acquisition and the analysis of data for the work.. This can be attributed to the tightly clustered musculature of the mandible, as the ventral-dorsal action of the medial masseter pars zygomaticomandibularis and the medial masseter pars zygomaticomandibularis counterbalance the bending moment during chewing, thus providing support to the articulated surface of the joint.. Muscle forces were applied at their anatomical attachment points, according to previously reported results on the masticatory muscle architecture and its involvement in the initiation and stabilization of the mandible movement (Hautier and Saksiri,). It seems that the effect of biting type, although apparent, is less pronounced than that of the food type.. Periodontal loading It is notable that the mastication forces during chewing were considerably cushioned by the periodontal ligament, thus preventing overloading of the alveolar bone and isolating the masseter ridge from abrupt loading.. Due to its small proportions, the temporal muscle was considered to bear only 5% of the mandible closing force (F_z) providing however 40% of the anterior-posterior stabilization (F_x).

This ensured the use of optimum mesh density in terms of processing time vs Results accuracy, while maintaining vital geometric characteristics (feature lines) throughout the model.. This is indicative of the overall deformation of the mandible during gnawing, which is significantly higher than the one observed during chewing, thus provoking strain induced stress throughout the mandible.. stl files (triangle surface models) of the bone contour through software programs.. Two masticatory scenarios were identified, gnawing (incisal biting), and chewing (molar biting) and both of them examined for two load intensities, corresponding to a food type each (i.e.,), as follows: • > The posterior fibers of the temporal muscle, only involved in mandible retraction, were not considered during the biting scenarios.. g, bone and dentine) All model entities representing hard tissue were reverse engineered in independent steps and then combined into the final model.. Although these morphological modifications to environmental influences (e.g., feeding ecology) can be detected by inbreeding laboratory strains, the trigger of this evolution is difficult to isolate since postnatal skull growth in rodents occurs preferentially in some parts of the mandible such as the mental foramen.. He was also involved in the preparation of the manuscript and sanctioned the publication of this version.. Teeth loading Loading patterns occurring during chewing were more pronounced in molars when compared to incisors, where the stress was observed at their posterior part (Figure).

Different stress fields within the periodontal ligament were experienced during the various biting scenarios (Figure). A gross muscle screening is performed on a patient when a quick assessment of the patient's general level of muscle strength is required.. The masticatory musculature was considered to produce a combined force inversely proportional to the fracture strength of the food type (applied for each biting scenario on incisors or molars).. The model was subjected to four loading scenarios simulating different feeding ecologies according to the hard or soft type of food and chewing or gnawing biting movement.. To achieve this, a 3D model of mouse skulls was reconstructed based on Micro Computed Tomography measurements.. The development of increasingly complex and sophisticated FE models has contributed to a comprehensive understanding of the in situ mechanical response of biological systems (Yang et al.

; Renaud et al.,) If this hypothesis holds true, then this micro-evolutionary pathway would be by far more direct in shape remodeling than the genotypic influences recruited in macro-evolutionary trends (Schluter,). It is important to remember that the gross muscle screening does not detail the determination of strength; it only provides the clinician with information as to whether a region of the body is either normal or weak.. Chewing resulted in higher stress values covering the area of the anterior margin of condylar articular surface to posterior-ventral tip of condyle up to the minimum of depression formed by condyle and processus angularis.. Materials and methods A mouse skull (C57Bl/6-Sv129 genetic background) was scanned by μ CT in order to reconstruct a 3D model required for the intended analysis.. Although the results indicated a linear correlation of this effect to the applied load, this cushioning is in reality expected to fade along with an increasing masticatory force.. In order to consolidate

this hypothesis, we undertook an in-situ approach that explores the importance of stress fields induced on the mouse mandible by masticatory loading.. NM: Contributed to the development of the model, the analysis and the interpretation of data for the work.

Chewing and gnawing resulted in varying loading patterns, with biting type exerting a dominant effect on the stress variations experienced by the mandible and loading intensity correlating linearly to the stress increase.. Upon segmenting the main hard tissue components of the mandible such as incisors, molars and alveolar bone, boundary conditions were assigned on the basis of the masticatory muscle architecture.. The distant nature of this load (applied on the incisor) to the temporomandibular joint contributes to a bending of the mandible that significantly increases the overall stress values during gnawing, which is especially noteworthy in the cross-section of the incisor spanning from the anterior margin of muscle insertion area on ventral site of incisor ramus to the minimum of depression on dorsal side of incisor ramus (Figure). ,) In the present study, micro Computed Tomography (μ CT) and FE modeling techniques were employed to determine whether different masticatory forces and movements are able to significantly alter the stress/strain equilibrium of the mouse mandible.. Another noteworthy aspect is that incisal biting also resulted in stress accumulation in the periodontal ligament, even though no loads were applied at the molars.. The posterior part of the temporal muscle attaches on the anterior border of the ramus of the mandible initiating from the short coronoid process up to the last molar covering a total of 782 element nodes.. The development of a mesh independent grid was considered an intrinsic aspect of developed model, as achieving a sufficient degree of bio-realistic is a problem inherent to computational biomechanics (Tsouknidas et al.. The fragments, considered during the compression tests, were in these terms similar in size to the rodent's oral cavity e.. Mice are arguably the dominant model organisms for studies investigating the effect of genetic traits on the pathways to mammalian skull and teeth development, thus being integral in exploring craniofacial and dental evolution.. Missing model entities (i e , soft tissue) were manually re-constructed (in ANSA 15.. Data acquisition was in accordance to DICOM (Digital Imaging and Communications in Medicine).. However, the mandible of rodents is exposed to diurnal forces of high complexity and therefore the effects of mechanical loadings remain unclear due to limitations inherent to current experimental models.. This limitation is attributed to the linear-elastic nature of the introduced model, as there is no literature available concerning the nonlinear-viscoelastic material properties of the periodontal ligament.. Computational methods may offer a good alternative to heuristic/experimental methodologies having the potential to answer important endured questions and confirm or not generalized assumptions on the mechanobiology of mandibles.. A multi threshold segmentation technique was employed for the purpose of this study and the mean gray-scale within the image was calculated by employing sensitive edge detection filters, to distinguish the apparent tissue types (Rathnayaka et al.. ,) In this sense, the verification of the theoretical model was achieved through entity based convergence studies (Zienkiewicz and Taylor,).. The exerted forces are expected to vary depending on the food stiffness and biting type (i.. As the size of the food pellets was disproportionately large to the mouse skull dimensions, the gnawing/chewing load was established on the basis of fragmented pellet bites fitting the animal's mandible size.. These loads were equally distributed over the molars and incisors (both sides) as literature advocates bilateral biting to be more realistic than unilateral (Weijs and Dantuma,).. There exists, however, a consensus throughout literature that highly accurate models (on the micro scale) require semi-automated segmentation, supported by manual correction of the threshold results by experienced operators.. This resulted in a 2D outline of the various model entities within every scan, while the 3D geometrical data set was generated by overlaying consecutive slices.. e , soft and hard food pellets) Gnawing was simulated with a purely vertical load applied at the tip of the incisors whereas chewing considered a loading direction inclined by 30° to the dorsal-ventral axis of the molars.. During gnawing, the mandible engages an oscillatory movement, which introduces a ventral-dorsal component to both the force applied to the incisor and the counter-acting musculature.. Most of the popular segmentation methods are based on purely automated methodologies reconstructing *.. ,) A bio realistic representation of all model entities was achieved through sequential segmentation of specific gray values (e.. This ability can be negatively affected by such factors as pain, poor comprehension, motivation, cooperation, fatigue, and fear.. She was also involved in the preparation of the manuscript and provided approval for the publication of this version.. Introduction The developmental pathways related to rodent skull morphogenesis have been extensively studied in the past years, identifying the effect of all traits related to their DNA sequence on the shape of the various skull bones, including mandible (Yamada et al.. He also provided approval for the publication of this version LJ: Contributed to the development of the model and the interpretation of data for the work.. Over the past years Finite Element (FE) modeling has naturally evolved from traditional engineering disciplines to the study of living tissues, rapidly covering a broad spectrum of clinical applications (Tsouknidas et al.. ,; Colvin et al. ; Settle et al. ,) Recent studies suggested that the phenotypic plasticity of epigenetic processes such as dietary aspects and muscle driven remodeling could favor the selection of pre-existing variances (Mavropoulos et al.. Study on Bilinear Scheme and Application to Three-dimensional Convective Equation (Itaru Hataue and Yosuke.. This was favorable in terms of quality of the generated surfaces, as the overlapping density spectrums would otherwise result in loss of surface quality due to extensive noise in either one of these model entities.. 2 by Beta CAE Systems S A) Vol 7, No 3, May, 2004 Mathematical and

Natural Sciences.. This can be explained with simple lever mechanics, since the loading point in incisal biting is more distant to the fulcrum (temporomandibular joint) than during molar biting (chewing).. ,) The wide acceptance of medical modeling by the academic community has enabled FE to rise from its period of infancy to the point of becoming ubiquitous in biomechanics.. The aim of this study is to analyse the functional significance of masticatory loads on the mouse mandible and identify critical stress accumulations that could trigger phenotypic and/or growth alterations in mandible-related structures.. Author contributions AT and TM: Contributed to the conception of the hypothesis of the study, collaborated in the development of the model and was involved in the evaluation of the results and preparation of the manuscript.. Regardless of the type of muscle testing used, the procedure is innately subjective and depends on the subject's ability to exert a maximal contraction.. The fracture strength of these pellet fragments was determined experimentally, based on uniaxial compression tests, and applied as the masticatory load during the two biting scenarios.. e , chewing or gnawing) Consequently, food consistency could result in evolutionary divergence patterns triggered through altered mandibular growth.. The obtained results indicate that food consistency may be associated with micro evolutionary modifications in rodent mandible morphology that will overall impact on skull shape adaptations.. The temporomandibular joint was simulated by articulating the mandible surface contacting the temporomandibular disc at its medial-lateral axis.. Mandible loading The analysis indicated that the masseter ridge was one of the most stressed areas of the mandible, with incisal biting (gnawing) also resulting in stress augmentations of the mental foramen of the mandible as well as on the temporomandibular joint (Figure).. The simulation provided refined insight on the mechanobiology of the mouse mandible, indicating that food consistency could influence micro evolutionary divergence patterns in mandible shape of rodents.. He was also involved in the preparation of the manuscript and provided approval for the publication of this version.. This technique is capable of producing 2D images of various structures, based on their ability to withstand the emitted X-radiation.. These loads were allocated among the main six muscles, which are involved in rodent mastication (Cox et al.. Once the 3D model was reconstructed, the file was imported in a mesh-oriented pre-processor and translated into a volumetric model.. However, chewing resulted in stress concentrations that were tightly clustered in the in the dorsal part of the ramus, stressing the mandible to a higher intensity than the one observed during gnawing.. An example when a gross muscle screening would be used is when the clinician is preparing the patient to get out of a wheelchair and to ambulate using a standard walker—the clinician needs to determine whether the patient has sufficient strength to weight bear through the lower extremities and to weight bear through the upper extremities.. If any weakness is found during the gross muscle screening test, a specific muscle test is then performed.. As bone and all other hard tissues (e g , enamel, dentine) have a unique spectrum of X-ray permeability, they shade in different tones of white/gray within a CT slice, thus allowing their relatively unhindered segmentation with some minor overlapping of hard tissue types.. The correction of the defects required further attention in order to develop a model capable of accurately representing all details (external and internal) vital to the analysis.. g , slightly wider than both incisal edges, while height and depth were restricted to the inter-incisor distance.. As the project focused on the mouse mandible, only this part of the geometry was considered during the analysis to increase computational efficiency and results accuracy. e10c415e6f