应用可降解外套管防止移植静脉再狭窄的生物力学研究

纪广玉，邹良建，张宝仁，韩林，龚克勤，孙辉，柳兆荣
上海市第二军医大学长海医院胸心外科 上海 200433 E - mail:gyji72@ yahoo. com
上海市复旦大学生物力学研究所

目的　探讨用可降解外套管束缚移植静脉(VG)一段时间,防止 VG 再狭窄及其生物力学机制。

方法　以 18 条犬的股静脉和颈外静脉调转按相同伸长比端 - 端吻合至同侧股动脉和颈总动脉,其中一侧股动脉和颈总动脉的移植静脉外加可降解外套管为实验组,不加外套管侧为对照组。可降解外套管采用聚乳酸 - 聚乙醇酸(PLGA),降解速度 6 周。术后 4 小时、1 天、1 周、2 周、4 周、6 周、8 周、12 周时间再次手术。术中测量动脉压力、桥血管压力、血流量,VG 的零应力、张开角、P - V 关系;多普勒超声检查 VG 是否通畅,内膜、中层和管腔的变化,桥静脉内径、外径;VIII 因子染色观察内皮细胞(EC)完整性,VB 染色分析胶原纤维和弹力纤维,α-actin 抗体检测平滑肌(VSMC)。Leica 图象分析仪定量计算移植静脉中段内膜、中层厚度、血管腔面积、VSMC、弹力纤维和胶原纤维含量变化等。

结果　(1) 移植血管前后动脉压无明显变化,超声检查未见吻合口狭窄,PLGA 外套管在 5W 时失去力学支撑作用,6 周时快速降解为小颗粒状;

(2) 血管结构变化:① 内皮细胞:实验组和对照组术后 4 小时内皮细胞 40% 和 60% 脱落,1 天后约 70% 和 80% 脱落,1 周 内皮细胞 80% 和 50% 再内皮化,2 周均 100% 再内皮化;② 静脉内膜、中层厚度、血管腔面积:对照组(无外套管)术后 4 小时见血管壁水肿,中层结构完全破坏,大量多形核细胞(PMNs)浸润,1 周可见内膜轻微增厚,仍可见血管水肿和 PMNs 浸润;2 周可见内膜、中层增厚明显,管腔面积减小,内膜下可见迁移的平滑肌和胶原纤维沉积,中层平滑肌增多,排列紊乱 PMNs 已部分为纤维细胞代替,炎症反应轻;4、6 周内膜中层继续增厚,管腔进一步狭窄;8 - 12 周内膜中层增厚最明显,管腔面积减小,胶原沉积以教员为主;实验组(加外套管)术后 4 小时见血管壁水肿,中层结构较完整,多形核细胞(PMNs)浸润轻,1 周可见血管壁结构完整,内膜中层轻微增厚,仍可见血管水肿和 PMNs 浸润;2 周平滑肌层完整,排列整齐,内膜轻微增厚,管腔面积无减小,PMNs 已为纤维细胞代替,炎症反应轻;4 周内膜、中层继续增厚,内膜下可见迁移的平滑肌和胶原纤维沉积,量较对照组少($P < 0.05$),管腔面积减小不明显,与对照组差异显著;6 - 12 周内膜中层继续增厚,但其程度明显小于对照组($P < 0.05$),管腔面积无减小;③ 弹力纤维、胶原纤维含量:移植术后 4 小时即可见到对照组 VG 管壁弹力纤维明显断裂,实验组弹力纤维保持完好,术后 1、2 周见对照组较实验组内皮下、中层胶原纤维沉积明显($P < 0.05$);弹力纤维含量无明显变化;术后 4、6 周内皮下、中层胶原纤维沉积继续增多,对照组较实验组明显($P < 0.05$);弹力纤维含量增多,分布在中层和外膜,组间差异不明显($P < 0.05$);术后 8 周内皮下、中层胶原纤维含量组间差异显著,对照组明显增多($P < 0.01$);弹力纤维含量均增多,与移植前静脉相比差异显著($P < 0.05$);术后 10、12 周内皮下、中层胶原纤维含量较 8 周无明显增多,实验组与对照组差异显著,对照组明显增多($P < 0.05$);弹力纤维含量继续增多,实验组较对照组明显($P < 0.05$)。

(3) 血管力学特性改变:静脉移植术后切应力开始变小,术后 4 周,逐渐增大;术后 1 周开始,桥静脉张开角逐渐减小,张应力分布从 2 周开始实验组明显好于对照组。

结论　可降解外套管作为外支架防止移植静脉早期过度扩张,在 VG 逐渐适应动脉环境后自行降解,可防止 VG 再狭窄。其可能机制为:(1) 外套管可减轻移植后早期血管内膜的剥脱,加快内皮细胞修复;(2) 可降解外套管可减轻术后血管中层结构破坏;(3) 外套管可减轻内膜、中层增厚,血管腔扩大,使静脉重塑向有利的方向发展,从而防止静脉再狭窄;(4) 改变静脉移植后血管壁内膜到外膜的张应力梯度分布,减小内膜过高的张应力,从而使得 VG 发生良性重塑,防止静脉再狭窄。

The Association of Orientations of Wedge - Shaped Cervical Lesions of Teeth with Occlusal Forces

Bo HUO[1], Qing ZHANG[2], Jiade WANG[2]
1. *Institute of Mechanics*, *Chinese Academy of Science*, *Beijing* 100080, Email: huobo@ tsinghua. org. cn;
2. *School of Stomatology*, *Peking University*, *Beijing* 100081

Introduction　The wedge - shaped cervical lesion, generally characterizing with wedgelike shape and frequently subgingival location, is the loss of tooth structure at the neck of a tooth. It may be caused mainly by occlusal stress. The association between cervical lesions and occlusal attritions had been studied by some researchers. In the clinical diagnoses, authors observed that the wedge - shaped cervical lesions had different orientations. The lesions point to the coronal (CL), the middle (ML) and the root (RL) of tooth, respectively. In this paper, finite element analyses on how typical occlusal forces affect the orientation of cervical lesion are done, and then numerical predictions are compared with the results of an investigation about occlusal wear regions and orientations of cervical lesions.

Materials and Methods Two finite element (FE) models with same geometric profile as a maxillary premolar with a ML lesion and a mandibular premolar with a RL lesion are established. Referring to the definitions of typical occlusal forces of Zhou et al. (1989), six typical forces for maxillary premolar and three ones for mandibular premolar were applied on occlusal surface of teeth.

One hundred and twenty - four premolars (forty - six maxillary premolars and seventy - eight mandibular ones) were investigated. Both of occlusal wear and cervical lesion were present in these teeth simultaneously. For every tooth, occlusal wear region and orientation of cervical lesion were recorded.

Results Basing on FE results, the relation between typical occlusal forces and types of the produced lesions are given. Typical occlusal forces can be further related with occlusal wear regions. Therefore the types of cervical lesions can be predicted through the observed occlusal wear regions in the investigation. The results of observation and prediction are shown in Fig. 1. It can be found from Fig. 1 that the predictions for the maxillary premolars agree with the observation results by and large. Especially, we predict fifteen teeth with ML correctly and only are four ones given by error. In 44 mandibular premolars with RL, 75 percent are predicted correctly. In addition, FE results show no CL for mandibular premolar. There were 4 mandibular premolars with CL, which occupies 5% of total investigated teeth. That also agrees with prediction. This work, however, only provides a simple explanation for a phenomenon observed clinically, so more effort should be made.

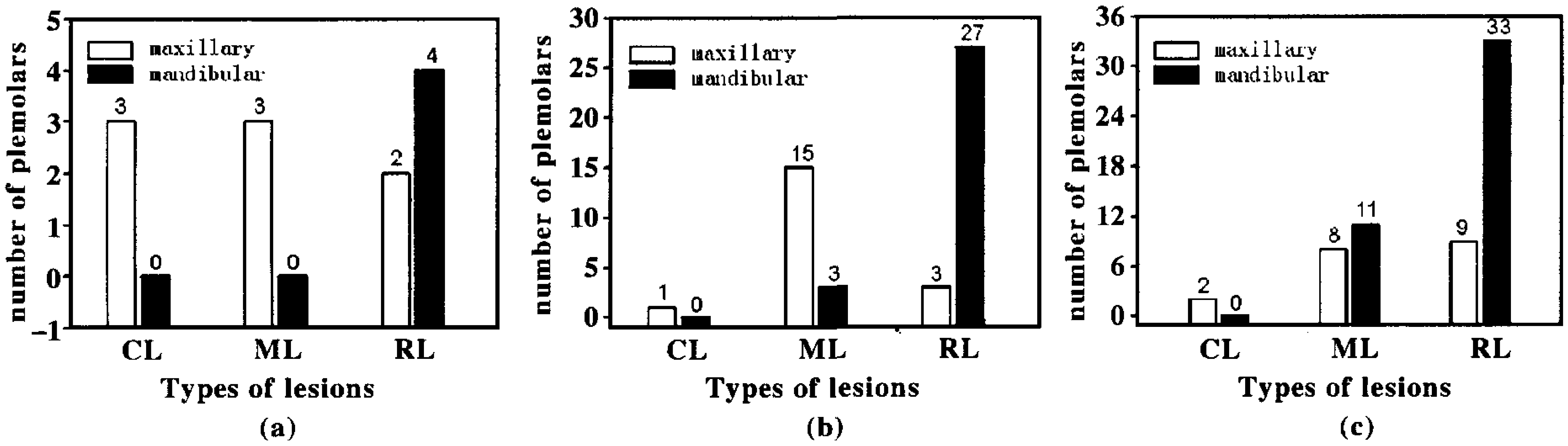

Fig. 1 The predicted orientations of cervical lesions for the observed teeth with (a) CL, (b) ML and (c) RL

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An Inhomogeneous and Anisotropic Constitutive Model of Human Dentin

Bo HUO

Institute of Mechanics, Chinese Academy of Science, Beijing 100080, Email: huobo@tsinghua.org.cn

Introduction In human dentin, microscopic tubules extend through the entire dentin with variational diameters. The peritubular dentin encircles the tubules and is characterized by its high mineral content. The intertubular dentin occupies the volume outside of peritubular dentin and contains more collagen and less mineral than the peritubular dentin. The above structural characters of dentin should lead to an inhomogeneous and anisotropic stress - strain relation of dentin. In the past years, a lot of experiments based on the microscopic structure of dentin had been done. Some attempts on theoretically modeling constitutive law of dentin were also presented. Here author gives an inhomogeneous and anisotropic constitutive model of human dentin, considering the difference of peri - and intertubular dentin, and compare the FEA results basing on this model with the moiré fringe testing results of Wang and Weiner (1998).