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· 综述 ·

牙釉质发育不全诊疗策略的研究现状

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【摘要】 牙釉质发育不全是一种牙齿在发育过程中受到遗传或环境因素影响而导致牙釉质形成或矿化障碍的疾病, 可导致患牙颜色异常、结构缺损, 患者表现出牙齿变色、牙齿敏感、牙体缺损等临床症状, 可严重影响患者咀嚼、吞咽、语音和笑容, 给患者带来身心上的不适。本综述总结了牙釉质发育不全在基因调控水平发生异常以及后天发育中环境因素改变所致的发病机制, 根据该疾病的常用分类列举了一系列临床诊断要点, 这些要点包括: ①轻型牙釉质发育不全仅有患牙颜色及透明度的改变; ②病损常成组对称出现; ③根据患者受侵犯的牙齿可以推测在牙齿发育期间, 全身疾病或营养障碍等发生的年龄; ④釉质表面形成的带状或窝状棕色凹陷, 易与氟斑牙混淆; 阐述了在轻重症患者中根据患者不同主诉需求综合运用牙齿漂白、脱敏治疗、直接或间接修复等治疗策略, 并提出了在婴幼儿重症患者中运用多学科协同序列治疗的新理念。本文旨在为临床医生提供有关牙釉质发育不全的最新知识和指导, 目前有关该疾病的文献资料主要局限于病例报道, 未来还需要更多高质量的临床研究与系统评价, 以进一步规范该疾病的诊疗策略。

【关键词】 牙釉质发育不全; 牙釉质矿化不全; 牙釉质成熟不全; 遗传性釉质发育不全; 发病机制; 临床诊断; 治疗策略; 序列治疗

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【Abstract】 Enamel hypoplasia is a disease that results in enamel formation and mineralization abnormalities due to the effects of hereditary or environmental variables during tooth development. Affected teeth may appear to have an aberrant color and structural flaws. Patients often display clinical signs such as tooth defects, tooth sensitivity, and tooth discoloration. The disease can cause patients to feel physically and mentally uncomfortable and negatively impact their ability to chew, swallow, speak, and smile. In this review, the pathophysiology of enamel hypoplasia, which is caused by anomalies in gene regulation and changes in environmental variables, is summarized, along with a list of clinical diagnostic indicators based on the most commonly used disease classifications. The main points are as follows: ① enamel hypoplasia changes only the color and transparency of the affected teeth; ② lesions often occur symmetrically in groups; ③ the age at which systemic diseases or nutritional disorders occur during tooth development can be predicted based on the patient's impaired teeth; and ④ banded or pitted brown depression on the enamel surface can easily be confused with dental fluorosis. It also elaborates on the comprehensive application of tooth bleaching, desensitization, direct or in-

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direct restoration and other treatment modalities according to unique chief complaints by different patients and suggests the use of multidisciplinary cooperative sequential treatment for critical infants and young children. The goal of this review is to provide professionals with the most recent information and advice about enamel hypoplasia. Current literature on this condition is primarily case reports. To further standardize the diagnostic and management approaches for this disease, additional high-quality clinical research and systematic reviews are required.

【Key words】 enamel hypoplasia; enamel hypocalcific; enamel hypomaturational; amelogenesis imperfecta; pathogenesis; clinical diagnosis; treatment strategy; sequential treatment

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牙釉质发育不全是一种牙齿发育异常的疾病,其病因可能是营养不足、内分泌紊乱、孕期过程受到影响或者其他局部因素,造成牙釉质矿化不良,甚至导致牙齿存在实质性缺损的一种病理状态。轻度牙釉质发育不全的牙釉质形态基本完整,但在色泽和透明度方面有所改变,会形成白垩斑的釉质,患者一般无自觉症状。重度牙釉质发育不全的牙面存在实质性缺损,表面出现带状和窝状的棕色凹陷。牙釉质发育不全可分为遗传性和非遗传性两大类,遗传性又可分为常染色体显性、常染色体隐性和X连锁遗传型,非遗传性又可分为局部性和全身性。牙釉质发育不全的患病率根据不同的诊断标准,在不同地区和人群中有所差异,其患病率约为15%^[1]。

1 牙釉质发育不全的发病机制

1.1 遗传因素

由于基因突变或染色体异常导致牙釉质形成细胞的功能障碍或数量减少,影响牙釉质的分泌和成熟^[2]。牙釉质基质形成和代谢的相关蛋白质和基因异常是遗传学因素的主要表现。牙釉质基质矿化过程中的信号通路调控是分子生物学因素的主要表现。遗传学因素主要涉及到牙釉质基质形成和代谢的相关蛋白和基因的异常,如X-连锁釉原蛋白(amelogenin X-linked, AMELX),釉质素(enamelin, ENAM),基质金属蛋白酶20(matrix metalloproteinase 20, MMP20),激肽释放酶相关肽酶4(kallikrein related peptidase 4, KLK4),序列相似家族83成员H(family with sequence similarity 83 member H, FAM83H)等^[3-6]。分子生物学因素主要涉及到牙釉质基质的矿化过程中信号通路的调控,同源盒转录因子3(distal-less homeobox 3, DLX3)基因突变可能是导致釉质发育不全的直接原因之一^[7]。

1.2 环境因素

感染、营养不良、药物、放射线、外伤、代谢性疾病等对牙齿发育期的干扰,造成牙釉质形成细胞的损伤或死亡,常导致牙釉质的缺陷或缺失。主要包括婴幼儿时期感染严重的全身疾病,如高热、肺炎、麻疹、猩红热等;或婴幼儿时期发生了严重的营养障碍,如维生素A、维生素D和钙磷的缺乏等^[8-10]。另外,牙釉质发育不全的病因涉及遗传和环境因素的相互作用^[11]。遗传基因突变对牙釉质形成过程产生直接影响,而营养缺乏、传染疾病、先天问题、钙代谢异常、出生损伤、感染、化学物质暴露等环境因素可能进一步加剧牙釉质的异常发育。

2 牙釉质发育不全的临床诊断

根据 Witkop 分类,牙釉质发育不全可分为发育不全型(hypoplastic)、成熟不全型(hypomaturational)、矿化不全型(hypocalcific)及复合型^[12]。发育不全型体现在牙釉质数量上的缺失,临床可见牙釉质厚度降低,出现点状凹陷或带状缺损,但釉质硬度及色泽正常,X线片上可区分釉质及牙本质。成熟不全型的牙釉质厚度正常,矿化程度稍低,颜色常不均匀,可呈现出黄褐色色斑,影响美观。矿化不全型体现在牙釉质质量上的缺失,釉质硬度下降,质地松软导致极易磨损,患者常出现牙齿敏感等临床症状,X线片上难以区分釉质与牙本质。复合型则表现为混合的病理特征,患牙可伴有牛牙样改变。在临床诊断时,可根据患牙是否具有实质性缺损简单分类为轻型与重型两类^[13],其诊断标准和诊断方法主要有以下几点:①轻型牙釉质发育不全仅有患牙颜色及透明度的改变,常表现为乳白色或黄褐色的色斑;重型牙釉质发育不全会出现患牙表面的结构缺损,常表现为

点状凹陷或带状缺损。②病损常成组对称地发生,但由严重乳牙感染或外伤导致的牙釉质发育不全常只累及单个恒牙。③根据患者受侵犯的牙齿可以推测在牙齿发育期间,全身疾病或营养障碍等发生的年龄。患者在婴幼儿时期可有相关营养不良或代谢病史,患者家系中可有其他人有类似症状。④釉质表面形成的带状或窝状棕色凹陷,易与氟斑牙混淆。诊断要点是白垩色斑的周界比较明确,而且其纹线与釉质的生长发育线相平行吻合;氟牙症为长期性的损伤,故其斑块呈散在的云雾状,周界不明确,并与生长发育线不相吻合。釉质发育不全可发生在单个牙或一组牙;而氟牙症发生在多数牙,尤以上颌前牙和下颌第一恒磨牙为多。⑤与龋病进行鉴别诊断,注意龋病无对称性,且发生色形改变的部位质地变软。

除了常规的临床检查和影像学检查外,还可以利用分子生物学技术对牙釉质发育不全的遗传基因进行分析,以明确病因和类型^[14]。此外,还可以采用光学相干断层扫描仪等无创检测手段,对牙釉质的结构和厚度进行定量评估^[15-16]。

3 牙釉质发育不全的治疗方案

牙釉质发育不全常见于牙齿表面粗糙、脆弱、易碎和变色,对于釉质矿化不全的患者还具有更高的患龋风险^[17-18]。此外,牙体硬组织长期的缺损或质地下降还会对牙髓-牙本质复合体造成不利影响,使得患者更易罹患牙髓或根尖周疾病。这种情况会影响患者的咀嚼、吞咽、语音和笑容,给患者带来身心上的不适^[19]。因此,治疗牙釉质发育不全的目的是改善牙齿的功能和美观,减轻或消除牙齿敏感,恢复正常的咬合关系和牙列间隙,提高患者的生活质量和自信心。在选择治疗方法时,需要综合考虑患者的年龄、牙齿发育情况、牙釉质缺损程度、牙齿美学要求、经济条件等因素,以及可能出现的并发症和风险。

3.1 轻型牙釉质发育不全的治疗

轻型牙釉质发育不全主要是患牙色泽和透明度的改变。其治疗方式包括牙齿漂白、直接修复和间接修复^[20]。牙齿漂白作为一种简单且无创的方式,是改善变色牙的常用治疗方案^[21]。临床所用的漂白药物主要为过氧化氢和过氧化脲两类,该类物质通过产生自由基,去除牙齿内部的着色基团,从而达到改变牙色的目的。牙齿漂白可以提高牙齿的美观度,但也有一些不利的影响,术后最常出现的临床症状常为牙齿敏感,并存在操作

不规范导致树脂粘接剂材料的粘接性能下降的可能^[22-23]。此外,牙齿漂白也不能保证长期的效果,进行诊室漂白的患者常需要多次就诊以达到最终效果,也可通过家庭式漂白的方式保证漂白药物的持续作用,但对患者的依从性要求较高。另一种微创的替代方法是渗透树脂治疗,它可以用来治疗前牙区的白垩色非洞缺损,树脂渗透可以平衡白垩斑与正常釉质之间的颜色差异,使其与健康牙釉质色泽相协调^[24-26]。

由于釉质的发育缺陷导致釉质厚度不足或硬度下降,患牙极易发生磨耗及磨损,导致牙本质外露,牙釉质发育不全的患者常常兼有牙齿敏感等症状^[27]。对于美观要求不高的患者,可首先采用家庭护理以及专业干预的方法,以一种保守且无创的方式缓解敏感的症状。家庭护理可包括建议患者使用抗脱敏牙膏或漱口水,若持续2~4周症状仍无有效改善,可采用专业干预的方式进一步进行治疗,其方式包括局部运用氟化物凝胶^[28]、涂布树脂粘接剂封闭牙本质小管、或采用生物激光治疗^[29-30]。若2~4周后症状仍无明显改善,可进一步运用树脂充填、全冠修复,此时可达到缓解敏感及改善美观的目的。

3.2 重型牙釉质发育不全的治疗

重型牙釉质发育不全的患者会出现牙釉质不同程度的缺损,若缺损仅为少量点状凹陷且患者没有明显敏感症状,治疗方式以提高口腔卫生意识,预防龋坏为主,可运用窝沟封闭、预防性树脂充填等临床技术^[31]。当出现广泛且较深的缺损,影响患牙美观及功能时,早期行树脂充填或间接修复是保护牙髓组织的重要措施。据报道,牙釉质发育不全的患者具有更高的患龋风险,这可能与牙齿的高敏感性使患者口腔卫生维护变难有关,因此预防龋坏是一项重要的任务。树脂充填作为一种直接修复方式,相比于间接修复具有牙体预备量小,微创的优点^[32-33]。牙釉质发育不全的牙齿一般不会影响树脂材料的粘接性能,但支持这一观点的证据有限^[34-35]。间接修复包括贴面、嵌体以及全冠修复,其相比于直接树脂修复能够更好地恢复牙体外形,可帮助关闭前牙区域的开放咬合关系和过大的牙列间隙,同时也能保护余留牙体组织,增强牙齿的稳定性和耐用性,改善患牙色泽,其缺点是牙体预备量较大,可能损害牙髓组织并且具有严格的适应证^[36-37]。间接修复也需要选择合适的材料和技术,以避免材料过敏、变形、脱落或感染等问题。间接修复还需要定期复查和

保养,以防止修复体松动或破裂等问题。

牙釉质发育不全还可能会伴随着牙髓或根尖周组织的损伤,需要进行相应的治疗^[38]。这种治疗可能包括根管治疗、根尖切除术或拔除等,但这些治疗也有可能会损伤牙齿的生理功能和结构。此外,这些治疗也需要进行严格的消毒和操作,防止细菌侵入或扩散引起更严重的并发症。

成年牙釉质发育不全患者常见临床主诉及治疗方案总结见图1。对于乳牙列患者,常常需要运用涂氟、玻璃离子充填、金属预成冠、乳牙拔除与间隙维持等治疗方式^[39-41]。部分重型牙釉质发育不全的患者可在乳牙列期或混合牙列就出现广泛性患牙的不同程度缺损,患者早期便有温度、化学、机械刺激敏感等症状,口腔卫生难以维护,龋坏进展迅速且磨耗进展快,并且可能出现恒牙迟萌、咬合关系紊乱等一系列问题^[42-44]。对此类患儿应当早期进行干预,保护牙髓组织,降低后期治疗的复杂程度,也为成年后的修复治疗做好准备^[45]。其治疗措施主要包括再矿化以及脱敏治疗缓解敏感症状,口腔卫生指导、窝沟封闭等措施预防龋坏,玻璃离子充填、复合树脂充填、预成冠等方式恢复牙体正常外形与咬合功能^[46],并通过早期正畸治疗纠正不良的咬合关系。当乳磨牙磨耗严重、后牙区垂直高度丧失较多时,可能会导致第一恒磨牙萌出困难,此时使用预成冠人为地抬高咬合,为恒磨牙提供垂直萌出空间是有必要的^[47]。

4 未来的研究方向和挑战

一方面,研究者应开发更有效且安全的预防措施,以降低牙釉质发育不全患者的龋病风险;并

同时研究更多种类和性能的修复材料和技术,以满足不同患者的个性化需求;另一方面,应探索牙釉质发育不全的更多病因和分子机制,以便进行早期诊断和干预。同时关注牙釉质发育不全患者的心理健康和生活质量,提供综合性的口腔保健服务。

序列治疗是一种动态的治疗方法,强调在疾病的不同阶段以特定的顺序和时间给出不同的治疗方案,并常需要多学科专家的共同参与。由于牙釉质发育不全是一种发育性疾病,其影响涉及乳牙列、混合牙列以及恒牙列,其诊断与治疗都需要多学科合作以及长期随访^[48-49]。具体而言,对于儿童时期的患者,儿童口腔医生可在疾病的早期阶段便诊断出该疾病,提供长期的口腔卫生指导,并为恒牙萌出提供必要的间隙维持;正畸医生也可在此阶段开始早期的正畸治疗,纠正不良的咬合关系;对于青少年阶段,牙体牙髓医生与修复医生可提供直接或间接修复治疗,恢复患牙外形与功能,牙周科医生可参与进行牙周状况的进一步维护,必要时可行牙冠延长术为其他修复方式提供便利;对于成年阶段,将由修复科医生对患者的个性化需求制定最终的修复方案,满足患者对功能以及美观的需求。重度牙釉质发育不全的患者常常具有多种口腔问题,还需要更加规范化的文件以协调各学科专家之间的介入时间与诊疗流程,更好地解决此类患者的临床问题。

5 总结

牙釉质发育不全是一种常见的牙体发育异常,会影响牙齿的色泽、形态、硬度和耐磨性,导致牙齿敏感、龋易感性上升、不美观等问题。及时诊

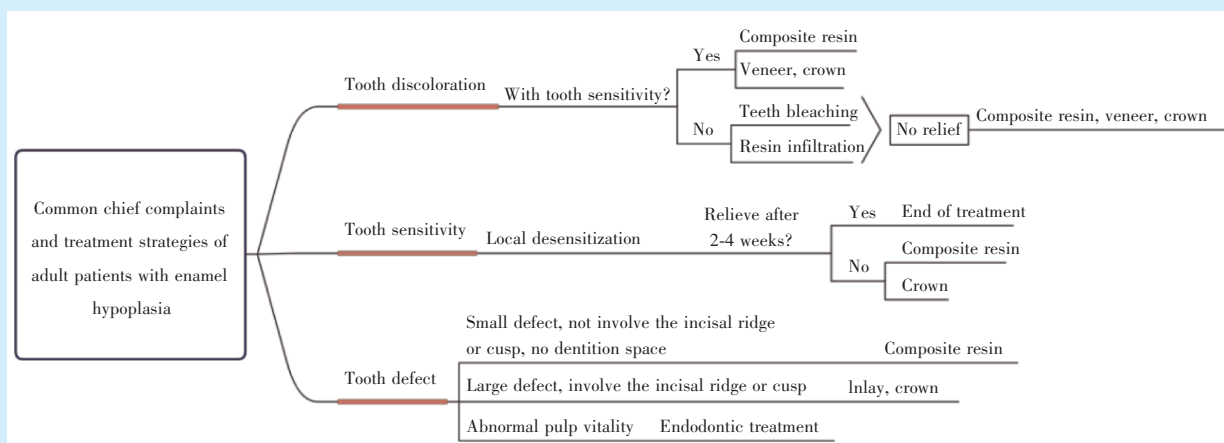


Figure 1 Chief complaints of and treatment strategies for adult patients with enamel hypoplasia

图1 成年牙釉质发育不全患者常见临床主诉及治疗方案

断和治疗牙釉质发育不全是非常重要的,可以防止牙齿进一步损伤,提高患者的生活质量和自信心。治疗方法主要根据病情的严重程度和患者的需求选择,包括牙齿漂白、局部涂氟、树脂充填、贴面或烤瓷冠等。为了更好地预防和治疗牙釉质发育不全,还需要进一步深入研究其发生机制、遗传因素、诊断标准和治疗效果,并进一步将序列治疗的概念引入该疾病的诊疗过程中,为临床工作提供更科学的依据和指导。

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