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引导骨再生术(GBR)相关膜暴露的风险防控策略

徐建刚[1,2]，谢怡文[1,2]，何福明[1,2*]

[1]浙江大学医学院附属口腔医院，浙江 杭州
[2]浙江省口腔生物医学研究重点实验室，浙江 杭州
Email: *hfm@zju.edu.cn

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摘 要

膜暴露是引导骨再生(Guided Bone Regeneration, GBR)术后最常见的并发症，若不及时处理，会影响骨再生过程甚至导致手术失败。因此，本文就口腔种植手术中GBR相关膜暴露进行分级和分类，探究不同屏障膜暴露的发生率及其对种植成功率和骨再生的影响，并提出适当的预防和处理方法，旨在为临床医生提供诊疗思路和防控策略。

关键词

引导骨再生，并发症，膜暴露

The Prevention and Treatment Strategies of Membrane Exposure in Guided Bone Regeneration (GBR)

Jiangang Xu[1,2], Yiwen Xie[1,2], Fuming He[1,2*]

[1]The Affiliated Stomatology Hospital, Zhejiang University School of Medicine, Hangzhou Zhejiang
[2]Key Laboratory of Oral Biomedical Research of Zhejiang Province, Hangzhou Zhejiang
Email: *hfm@zju.edu.cn

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Abstract

Membrane exposure is the most common complication after Guided Bone Regeneration (GBR). If

*通讯作者。

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not treated in time, it will affect the process of bone regeneration and even lead to failure. This review grades and classifies GBR-related membrane exposure in oral implant surgery, explores the incidence of membrane exposure of different types and their impacts on implant success rate and bone regeneration, and proposes appropriate prevention and treatment measures, aiming to provide clinicians with diagnosis and treatment ideas as well as prevention and control strategies.

Keywords

Guided Bone Regeneration, Complications, Membrane Exposure

1. 引言

GBR (Guided Bone Regeneration)，即引导骨再生术，由 Dahlin 等[1]提出的“引导组织再生术”的生物学原理发展而来，以“最早在组织缺损处增殖的细胞类型决定了创口愈合的类型”为理论依据，主张通过可吸收或不可吸收屏障膜，机械性隔绝软组织细胞(上皮细胞、成纤维细胞等)向缺损区迁移和增殖，从而避免对膜下方骨缺损区成骨过程的干扰；同时屏障膜为骨替代材料创造和维持空间，并允许氧气和养分进入移植部位[2] [3]。理想的屏障膜应具有以下特征：生物相容性，组织整合性，尺寸稳定性，可操作性，选择渗透性和空间维持性[4] [5]。基于这些概念，开发了各种各样的屏障膜，其目标是在 GBR 治疗中实现更高的可预测性，更低的并发症风险和更短的手术时间[6]。长期研究表明，可吸收膜和不可吸收膜都可有效防止软组织细胞进入骨缺损区域并促进骨再生[3] [7]。

GBR 技术具有高度可预测性和技术敏感性。膜暴露是最常报告的术后并发症之一[8] [9]，可能造成骨替代材料污染甚至局部组织感染，导致手术失败。本文旨在就口腔种植手术中 GBR 相关膜暴露进行分类和分级，探究其发生率及不良后果，并提出适当的预防和处理方法，为临床医生提供诊疗思路和防控策略。

2. GBR 并发症的分类和分级

Merli 等[10]比较了使用可吸收膜和不可吸收膜时的 GBR 术后疗效和并发症，发现两组的骨增量效果和并发症发生率均无统计学差异，于是根据 GBR 术后愈合过程中对新骨形成的影响，把并发症分为次要(minor)并发症和主要(major)并发症。在最近的一项系统评价中[11]，Tay 等把创口裂开、小范围膜暴露和轻微感染归类为次要并发症，其患者水平发病率为 16.1%；把持续感染导致手术失败，需要将屏障膜、骨替代材料和种植体部分或全部去除的情况归类为主要并发症，发病率为 1.6%。Fontana 等[12]把使用不可吸收膜的 GBR 并发症分为手术并发症和愈合并发症。其中手术并发症分为三类：A 类，软组织损伤(穿孔或撕裂)；B 类，神经系统并发症(感觉异常或感觉迟钝)；C 类，血管并发症(出血)。愈合并发症分为四级：I 级，小范围(≤3 mm)膜暴露，无脓性渗出物；II 级，大范围(≥3 mm)膜暴露，无脓性渗出物；III 级，膜暴露，有脓性渗出物；IV 级，脓肿形成，无膜暴露。不同的分类和分级下，对创口愈合和骨再生的影响不同，相应的处理方法也有较大的差异。

3. 膜暴露的发生率

Pedro 等[9]系统评价了 29 项研究中 610 名患者的 853 个 GBR 位点，发现并发症总发生率为 7.85%，

其中手术创口裂开和膜暴露是最常见的并发症，但是均未造成严重后果，无需手术干预。Sakkas 等[13]对 112 名患者进行了 113 个位点的分期 GBR 术，术后 1 个月内有 22 名(19.5%)出现了术后并发症，其中吸烟患者占 17 名。Cucchi 等[14]统计了在下颌后牙区行种植同期 GBR 的 39 名患者共 106 颗种植体，其中 7 名(6.6%)出现愈合并发症，均发生在术后 6 个月内。Meloni 等[15]的一项前瞻性研究对 45 名种植同期 GBR 患者(63 枚种植体)进行了为期 3 年的随访，发现术后 1 至 2 周有 6 名患者(13.3%)的胶原膜暴露。同一团队的另一项前瞻性研究[16]对 18 名患者 22 个位点的 55 颗种植体进行随访，发现 3 名患者(13.6%)出线早期胶原膜暴露。

不同类型屏障膜的暴露率仍存在争议。根据 Tay 等[11]的一项系统评价结果，所用的屏障膜类型(可吸收膜或不可吸收膜)对术后并发症的发生率没有显著影响。Lim 等[17]的一项系统综述也发现，包括膜暴露，软组织裂开和急性感染/脓肿在内的软组织并发症的总发生率为 16.8%，其中可吸收膜为 18.3%，不可吸收膜组 17.6%，无统计学差异。然而，Roca-Millan 等[18]一项系统评价结果显示，与可吸收胶原膜相比，钛箔、钛网和含钛增强的不可吸收膜更容易出现伤口裂开和膜暴露，其平均暴露率为 23.81% (范围 0%~50%)。在 Wessing 等[19]的一篇关于可吸收膜的荟萃分析中，交联胶原膜(CLM)的膜暴露率(28.62%)比非交联胶原膜(NCLM)的膜暴露率(20.74%)高 30%。相比屏障膜的类型，技术敏感性被视为影响膜暴露发生率及相关 GBR 成功率的主要因素[20]。

4. 膜暴露的影响

屏障膜暴露后，口腔内的微生物会向暴露区迁移和定植，不仅引起软组织炎症，还会影响膜下方的骨再生过程。细菌的平均大小约为 0.5~5.0 μm [21]，所以理论上屏障膜的孔径小于 0.5 μm 时可以阻挡细菌。对于不可吸收屏障膜，由于致密聚四氟乙烯(d-PTFE)的阻隔层的孔径(小于 0.3 μm)比膨体聚四氟乙烯(e-PTFE)的孔径(0.5~30 μm)小得多[22]，因此当膜暴露时，e-PTFE 更容易出现细菌渗透。体外通过扫描电镜和组织学研究发现，e-PTFE 膜暴露于口腔 2~3 周时出现部分细菌渗透，4 周后，所有标本均出现细菌污染[23]。可吸收屏障膜的降解最早在术后 4~28 天开始发生，尽管交联胶原膜比非交联胶原膜更能抵御细菌降解和促进软组织愈合，然而两种可吸收膜在暴露于口腔中 1~2 周内均被完全降解吸收[24] [25]。据报道，可吸收性膜本身可能不易受到细菌污染，并且使用氯己定(洗必泰)等消毒剂的效果要比不可吸收膜更好[26]。

与具有自然愈合条件的部位相比，膜暴露部位的骨再生量显著减少。Garcia 等[27]发现，GBR 术后膜暴露部位的水平向骨增量比未暴露部位小 74%。Machtei 等[28]发现，膜暴露部位(0.5 mm)比未暴露部位(3.0 mm)的水平向骨增量下降 6 倍。Annibali 等[29]也报告称，膜暴露部位的骨增量(5.00 mm)显著大于膜未暴露部位(3.19 mm)。而且，不同时期的膜暴露对于 GBR 术后骨再生过程的影响也不同。多项研究表明[27] [28] [30] [31]，早期膜暴露(术后 4 周内)对新骨形成的影响比晚期膜暴露的影响更大。然而，与其他骨增量技术不同，GBR 手术中的主要并发症(膜暴露、脓液渗出及脓肿形成)通常不会影响原始骨体积[32] [33]。

5. 膜暴露的预防和处理

Makowiecki 等[34]的一项随机对照试验发现，种植手术和修复后 1 年的随访期内，在种植体-基台连接处局部涂敷 0.2%氯己定凝胶可以减少宿主的炎症反应，显著降低膜暴露率和骨丧失量。Meloni 等[15]在 GBR 术后 1~2 周发现可吸收胶原膜暴露，通过在暴露区域每天两次局部涂敷 0.5%氯己定凝胶，并每周对患者进行随访，治疗 3 周后均观察到软组织完全愈合。Ghensi 等[35]的一项病例报告中，在 GBR 术后 2 周拆线时发现不可吸收屏障膜部分暴露，嘱咐患者每日多次使用 0.12%氯己定漱口，每日 2 次涂敷

1%氯己定凝胶，每周 1 次监测及清洁菌斑，持续 4 周，2 年复查的影像学检查显示种植体边缘牙槽骨稳定，GBR 手术成功。Jung 等[36]对 GBR 术后 5~7 周创口开裂和膜暴露的位点局部使用 0.2%氯己定冲洗消毒，所有位点的软组织均在二期手术前愈合。Eskan 等[31]对于术后膜暴露的患者每两周进行 1 次复查，用双氧水清洁术区，所有暴露的屏障膜均在 6~7 周内降解或被软组织覆盖，没有出现进一步的并发症。由于对并发症的及时处理，以及高频率的随访和日常维护，早期创口裂开和小范围膜暴露的治疗结果令人满意。

屏障膜的大面积暴露容易造成生物材料的污染或感染，为了减小口腔内细菌对骨再生过程的影响，应尽快进行二次手术，去除暴露的屏障膜并进行无张力缝合[37]。Cucchi 等[14]认为，对于术后 1 个月内出现的早期膜暴露伴感染，需要同时移除所有种植体、骨替代材料和屏障膜以控制感染，同时局部及全身应用抗生素，2~3 个月后再重新进行 GBR 手术[12]。而对于不伴感染的晚期膜暴露，则使其自然愈合，不需要进行额外处理。其他主要并发症，如脓性渗出物或脓肿形成，即便在不存在膜暴露的情况下，也可导致 GBR 完全失败，需要立即移除种植体、骨替代材料和屏障膜，并进行全身抗生素治疗[12]。

另外，Park 等[38]研究发现，GBR 术中切口的位置会影响皮瓣坏死的概率，从而导致不同的膜暴露发生率。缺牙区牙槽嵴顶处 1~2 mm 宽度的牙龈为无血管区，为保证皮瓣的血供，切口要稍偏舌腭侧，避开该区。而厚牙龈生物型因其更丰富的侧支血供，切口对皮瓣坏死和膜暴露的影响不明显。为了最大程度降低并发症风险，临床医生应评估屏障膜暴露的风险因素，包括软组织生物型，角化黏膜宽度，皮瓣的厚度和弹性，前庭沟深度，骨缺损类型和大小以及屏障膜的类型，以区分不同病例的膜暴露风险，并制定最佳的手术计划[39]。术中需改良翻瓣技术，实现创口无张力闭合[40]。

6. 结语

GBR 扩大了种植手术的适应症，然而其技术敏感性可能会导致膜暴露等术后并发症。不同种类的屏障膜术后暴露的发生率和严重程度尚存在争议，但由于膜暴露对骨再生产生的不良影响，发生时需及时进行干预和随访。未来需要进一步研究不同类型屏障膜的暴露对临床参数的影响及其机制，从而在 GBR 术前、术中和术后进行更有效的预防和处理。

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