Case Report
https://doi.org/10.47990/0g1ny275

Photobiomodulation with infrared laser to control dental hypersensitivity in children with molar-incisor hypomineralization – clinical cases

Carla Marinho Barreto Gois[1], *Cinthya Jeanette Arias-Guillén*[1], *Fernanda Miori Pascon*[1], *Maria Beatriz Duarte Gavião*[1], *Carolina Steiner-Oliveira*[1].

Abstract: Molar-incisor hypomineralization (MIH) is a common developmental dental defect of permanent teeth, that negatively affects enamel and dentin, predominantly affecting permanent molars and occasionally impacting permanent incisors. Clinical manifestations of HMI are patient-specific and can be categorized by the extent and severity of the enamel defects. These classifications range from mild to severe and may include the loss of tooth structure. Additionally, HMI can give rise to pronounced aesthetic challenges and may elicit hypersensitivity in some cases. This study aimed to address gaps in literature by describing treatment for pediatric patients with HMI and managing dentin hypersensitivity. These case reports document patients with MIH-caused hypersensitivity who underwent photobiomodulation (PBM) treatment using a low-power infrared laser in four irradiation sessions. The following irradiation parameters were applied: energy of 2J, output power of 100 mW, for 20 s, in continuous mode, with a beam area of 0.04 cm^2, per point. The irradiation points targeted on the affected teeth were: one in the cervical area, one in the apical region of each root, and one in the occlusal region of the molars. Pain levels were measured using the Visual Analogue Scale before and after treatment. Following laser therapy sessions, the patients remained under observation and reported no complaints associated with the condition. It can be concluded that PBM therapy with a low-power laser effectively treats hypersensitivity in MIH, controlling discomfort and pain to improve the patient's quality of life.

Keywords: developmental defects of enamel; pain; molar-incisor hypomineralization; laser therapy; pediatric dentistry

Fotobiomodulação com laser infravermelho para controle da hipersensibilidade dentária em crianças com hipomineralização molar-incisivo – casos clínicos

Resumo: A hipomineralização molar-incisivo (HMI) é um defeito de desenvolvimento dentário comum em dentes permanentes, que afeta negativamente o esmalte e a dentina, acometendo os molares e ocasionalmente os incisivos. As manifestações clínicas são específicas do paciente e podem ser categorizadas pela extensão e gravidade dos defeitos do esmalte. Essas classificações variam de leves a graves e podem incluir perda de estrutura dentária. Além disso, a HMI pode dar origem a desafios estéticos e provocar hipersensibilidade. Este estudo teve como objetivo preencher lacunas na literatura, descrevendo o tratamento para pacientes pediátricos com HMI e controlando a hipersensibilidade dentinária. Esses relatos de casos documentam pacientes com hipersensibilidade causada por HMI que foram submetidos a tratamento de fotobiomodulação (PBM) com laser infravermelho de baixa potência em quatro sessões de irradiação. Foram aplicados os seguintes parâmetros de irradiação: energia de 2J, potência de saída de 100 mW, por 20 s, em modo contínuo, com área de feixe de 0,04 cm^2, por ponto. Os pontos de irradiação direcionados aos dentes afetados foram: um na região cervical, um na região apical de cada raiz e um na região oclusal dos molares. Os níveis de dor foram medidos por meio da Escala Visual Analógica antes e após o tratamento. Após as sessões de laserterapia, os pacientes permaneceram em observação e não relataram queixas associadas ao quadro. Pode-se concluir que a terapia PBM com laser de baixa potência trata eficazmente a hipersensibilidade na HMI, controlando o desconforto e a dor para melhorar a qualidade de vida do paciente.

Palavras-chave: defeitos de desenvolvimento do esmalte dentário, dor, hipomineralização molar-incisivo, terapia a laser, odontopediatria

[1]*Faculdade de Odontologia de Piracicaba, Universidade Estadual de Campinas - UNICAMP, Brasil.*

Fotobiomodulación con láser infrarrojo para controlar la hipersensibilidad dental en niños con hipomineralización molar-incisivo – casos clínicos

Resumen: La hipomineralización molar-incisivo (HMI) es un defecto dental común del desarrollo de los dientes permanentes, afectando negativamente al esmalte y dentina, afectando predominantemente a los molares permanentes y ocasionalmente impactando a los incisivos permanentes. Las manifestaciones clínicas de HMI son específicas de cada paciente y pueden clasificarse según la extensión y gravedad de los defectos. Estas clasificaciones varían y pueden incluir la pérdida de la estructura dental. Además, la HMI puede generar importantes desafíos estéticos, y poden desencadenar hipersensibilidad dental. El objetivo del estudio fue describir el tratamiento de pacientes pediátricos con HMI y el manejo de la hipersensibilidad dental. En esta serie de casos, se documenta a hipersensibilidad dental asociada con HMI que recibieron tratamiento de fotobiomodulación (PBM) con un láser infrarrojo de baja potencia, en cuatro sesiones. Se aplicaron los parámetros: energía de 2J, potencia de 100 mW, durante 20 s, en modo continuo, área de haz de 0,04 cm^2, por punto. Los puntos de irradiación fueron: uno en la zona cervical, uno en la región apical de cada raíz y uno en la región oclusal de los molares. Los niveles de dolor se evaluaron utilizando la Escala Visual Analógica (EVA) antes y después del tratamiento. Tras las sesiones de terapia con láser, los pacientes permanecieron bajo observación sin reportar quejas. La terapia de fotobiomodulación con láser de baja potencia demostró ser eficaz en el tratamiento de la hipersensibilidad dental asociada con HMI, controlando el malestar y el dolor, y mejorando la calidad de vida de los pacientes.

Palabras clave: Adefectos del desarrollo del esmalte, dolor, hipomineralización molar incisivo, terapia por láser, odontología pediátrica

Introduction

Molar-incisor hypomineralization (MIH) represents a qualitative anomaly in enamel formation that could stem from a combination of genetic predisposition and environmental influences.[1] This condition manifests itself as porous, soft, and chalky enamel, and often exhibits discoloration.[2,3] It usually affects permanent molars and can also involve permanent incisors, leading to specific aesthetic concerns and, in some cases, hypersensitivity.[1,4-7]

Increased porosity of enamel allows bacterial ingress into dentin tubules, particularly wider ones found in recently erupted teeth, contributing to the sensitivity mechanism observed in teeth affected by MIH.[8] Furthermore, there may be a correlation between MIH and caries lesions. When MIH lesions become more severe, they can cause structural loss, leading to hypersensitivity of dentin to mechanical stimuli. Two systematic reviews have approximated the worldwide prevalence of MIH to range between 13.5% and 14.2%.[9,10]

The recommended therapeutic strategies vary and depend on the severity and site of the condition, ranging from conservative to more aggressive interventions, such as sealing the pit and fissure, restorations, prosthetic rehabilitation, and extraction.[10] Hypersensitivity emerges as a primary concern in children with MIH, and while a standardized protocol remains elusive, photobiomodulation therapy (PBM) using low-power lasers has been cited as a promising treatment option.[11]

The interaction of low-power laser with pulp tissue through enamel and dentin exhibits photobiomodulatory effects, reducing pain and inflammation.[11,12] However, the precise mechanism underlying analgesia

is not yet fully understood, although there are indications of reversible blockade in sensory nerve fibers, both centrally and peripherally, that can release beta-endorphins, neurotransmitters that are known for their analgesic properties.[11,13,14] Thus, PBM therapy has shown potential as a desensitizing strategy in MIH patients, mediated by alterations in dental pulp nerve transmission. Therefore, this study aimed to address gaps in the literature by describing treatment for pediatric patients with MIH and managing dentin hypersensitivity, with photobiomodulation (PBM) with low-power infrared laser.

Clinical case reports

The case series was approved by the local Research Ethics Committee (protocol # CAAE 68848623.0.0000.5418), and informed consent was obtained and duly signed by both the parents and the child, in accordance with established ethical guidelines.

Clinical case 1

A seven-year-old male patient, accompanied by his mother, sought treatment at the Pediatric Dentistry Service of the Faculdade de Odontologia de Piracicaba, Universidade Estadual de Campinas, Piracicaba, SP, BR (FOP-UNICAMP), reporting pain and sensitivity to thermal and mechanical stimuli (such as brushing). Informed consent was signed by the mother for the treatment. The medical history revealed the diagnosis of glucose-6-phosphate dehydrogenase deficiency (G6PD), an enzyme crucial to safeguarding erythrocytes against oxidative stress, through the Guthrie test (heel prick test). Its deficiency can precipitate hemolysis in the presence of specific environmental factors, including certain medications, foods, and infections.[15]

Dental problems were noticed when permanent molars and incisors erupted. Clinically, extensive defects with loss of structure were observed on the occlusal and buccal surfaces of the upper (Fig.1A) and lower first molars (Fig.1B), upper left central incisor and permanent lower lateral incisors with structural loss on the buccal surface, with a yellow / brown color, while white/cream opacity was observed in the right upper central and lower central incisors (Fig.1C). On clinical examination, no associated caries lesion was observed, but severe hypersensitivity was reported in all affected teeth during tactile examination. After anamnesis and clinical examination, the patient was diagnosed with MIH (Figure 1).

The child consistently reported feeling discomfort during oral hygiene routines and when consuming cold beverages, a concern corroborated by the mother. This complaint persisted throughout the four treatment sessions.

After initial evaluations and identification of hypersensitivity in teeth 1.6, 2.1, 2.6, 3.6, and 4.6 (Figure 2), PBM therapy was performed using a low-power laser (GaAlAs laser λ = 660 nm, TherapyXT, DMC, São Carlos, SP, Brazil) with the following irradiation parameters: energy of 2J, output power of 100 mW for 20 seconds (s), in continuous mode, with a beam area of 0.04 cm^2, per point. The

Figure 1: *(A) Permanent upper molars affected by MIH. (B) Permanent lower molars affected by MIH. (C) Frontal view of permanent upper and lower incisors affected by MIH. (D) e (E) Right and left lateral views of permanent upper and lower incisors affected by MIH.*

irradiation points targeted on the affected teeth were: one in the cervical area, one on the apical region of each root, and one in the occlusal region of the molars. Four sessions of PBM therapy were conducted at weekly intervals. In the initial session, a sensitivity test was performed using an exploratory probe and compressed air from the triple syringe[16,17], followed by the Visual Analogue Scale (VAS) standardized for pain measurement [18], on a scale of 0 to 10, where 0 represented no pain and 10 indicated severe pain. Subsequent sessions utilized the same tests, and throughout treatment, the father observed an increase in patient cooperation with oral hygiene practices at home and observed an overall improvement in pain (Table 1).

Figure 2: *Low power laser irradiation in the cervical region of the permanent central incisor (2.1).*

Table 1: *Pain assessment with visual analog scale (VAS), before and after photobiomodulation therapy (PBM) with low-level laser therapy*

Session	VAS before PBM		VAS after PBM	
	Exploration Probe	Compressed Air	Exporation Probe	Compressed Air
1	5.5	7	1	3.5
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0

Following the completion of the four-session PBM protocol, subsequent follow-up consultations were conducted at intervals of 7, 14, 30, and 45 days. During these follow-up visits, a new sensitivity test was performed involving two different stimuli: friction with a Robinson brush for 3 s and compressed air from a triple syringe.[16,17] Throughout all follow-up sessions, a pain score of 0 was consistently reported. Oral hygiene instructions and preventive guidelines were reiterated to both the child and the guardians, given the persistent challenges the mother faced with brushing. Although the child reported

a zero pain score, analyzed by VAS, both before and after the laser application from the second session of laser therapy, complaints related to sensitivity to cold liquids and during brushing persisted. Only after nine months from the initial laser irradiation did the patient experience painful symptoms only when eating ice cream. To address this, restorative glass ionomer cement (FGM, Joinville, SC, Brazil) was applied to seal the affected upper and lower permanent molars affected by MIH. The patient also expressed aesthetic concerns regarding the color disparity observed in the upper permanent incisor (2.1), which was restored using light-cured composite resin (3M ESPE Dental Products, Sumaré, SP, Brazil). For 18 months, the patient has been under continuous monitoring in the Pediatric Dentistry Area by postgraduate students, under the supervision of experienced professors in the field, with no reported complaints related to MIH.

Clinical case 2

A six-year-old male patient, accompanied by his guardian, presented to the FOP-UNICAMP Pediatric Dentistry Clinic with a main complaint of pain, particularly exacerbated by sweets consumption. The guardian consented to treatment by signing an authorization form along with a free and informed consent form. During the medical history evaluation, the mother reported an uneventful pregnancy and a term cesarean section delivery. Clinically, demarcated opacities were evident in the enamel of some teeth. A cream-colored opacity was observed in the erupting upper central incisor (1.1) (Fig. 3A), while a brownish hue was observed in the permanent molars (1.6 and 4.6) (Fig. 3B and 3C). Caries lesions were not associated with these opacities (Figure 3), which led to a diagnosis of MIH. Upon tactile examination, sensitivity was reported on tooth 4.6, which showed structural loss on

Figure 3: *Frontal view of the initial presentation of the affected teeth. (A) Permanent upper incisor affected by MIH. (B) Permanent upper molar affected by MIH. (C) Permanent lower molar affected by MIH.*

the occlusal surface. The primary complaint centered on the discomfort experienced while eating sweets, with chewing occurring predominantly on the left side. The guardian also mentioned that the child was grinding his teeth and experiencing nocturnal pain, although no signs of wear or caries lesions were observed during the clinical examination.

To treat the sensitivity of tooth 4.6, PBM therapy was administered with the same parameters previously described, during four weekly sessions. A sensitivity test was conducted using two different stimuli: friction with a Robinson brush for 3 s and compressed air from a triple syringe.[16,17] These tests were performed before and after laser application, and a VAS was used to assess pain (Table 2). Throughout the four treatment sessions, the patient continued to report discomfort when consuming sweets, although improvement was observed during the final session.

Following the completion of 4 sessions of PBM, follow-up appointments were scheduled at intervals of 7, 14, and 30 days, with reports from both the patient and their guardians. Sensitivity tests were also carried out, with the friction of a Robinson brush and using air from the triple syringe. VAS was also applied to pain during these tests.

Six months after the first laser application, the child reported new pain complaints when brushing his teeth. To preserve the remaining structure and the patient's quality of life, the affected teeth (1.6 and 4.6) were sealed with resin-modified glass ionomer cement (SDI, Cordeiros Itajaí, SC, Brazil) and during follow-up, the patient did not report any new complaints.

The patient remains under observation in the Pediatric Dentistry Area, where postgraduate students, under the guidance of experienced professors in the field, have been monitoring his progress and with satisfactory resin-modified glass ionomer restorations for 11 months.

Table 2: *Pain assessment with visual analog scale (VAS), before and after photobiomodulation therapy (PBM) with low-level laser therapy*

Session	VAS before PBM		VAS after PBM	
	Friction	Compressed Air	Friction	Compressed Air
1	0	7	0	7
2	0	0	0	1
3	3	0	0	3
4	0	3	0	3

Discussion

MIH is a condition that affects the development of tooth enamel. However, the exact cause of this condition is not yet known. There are several theories about the cause of MIH, which can be classified based on the type of exposure a child experiences from the prenatal stage to the postnatal phase. Prenatal exposures include maternal smoking or certain infectious diseases during pregnancy, while perinatal exposures include premature birth, low birth weight, cesarean section, and complications during the birth process. Postnatal exposure to natal diseases can also be considered a cause in early childhood, along with the use of medications. Furthermore, genetics is also considered an etiological factor.

Although there are multiple hypotheses in the literature about the cause, it is generally agreed that it is a multifactorial condition.[2,3,19,20]

The diagnosis of MIH must be carried out appropriately, as clinically other types of enamel change could be confused, such as dental fluorosis, imperfect amelogenesis, and hypoplasia.[21] Therefore, MIH affects the first molars and/or permanent incisors, distinguishing it from other types of tooth defects.[2,21,22] The clinical characteristics of MIH vary between each patient and can be classified according to the extent and severity of the injuries as mild, moderate and severe, with or without loss of tooth structure.

Patients with MIH have been observed to have increased tooth sensitivity and sometimes compromised enamel, which can be more susceptible to mechanical and chemical damage. Hypersensitivity needs to be addressed because it does not allow for effective oral hygiene; therefore, an increased risk of tooth decay arises. Consequently, patients diagnosed with MIH require special dental treatment considerations and an oral care regimen focused on prevention and pain control by hypersensitivity.[3]

Treatment for MIH varies depending on the severity of the condition. Preventive measures such as fluoride varnishes and resin sealants can be used, as well as conservative procedures such as glass ionomer, infiltrating resins, fluoride varnish, pit and fissure sealant, and composite resins. In cases of extensive coronary destruction, steel crowns or indirect restorations using digital dentistry are recommended. To carry out the adhesion procedure, it may be required to remove the areas affected by MIH using drills, as these areas have unsupported enamel.[3,7,12,20]

There are gaps in the protocol for the treatment of hypersensitivity in patients with MIH. Hypersensitivity is a challenging factor in choosing treatment depending on the different degrees of severity of this condition, so the use of desensitization therapies aims to reduce painful symptoms.[4,6,22,23]

Based on available evidence, the use of low-power laser PBM is an effective and contemporary therapy for the treatment of dental hypersensitivity[12], and was the treatment of choice for the cases described above. The use of lasers is recognized to stimulate physiological cellular functions and reduce inflammation in pulp tissue. This activity promotes the production of sclerotic dentin, which leads to the internal obliteration of the dental tubules, thus providing sustained pain relief over periods of one week and three months, as demonstrated in the cases presented. This treatment is considered to have a lasting impact on dental hypersensitivity.[25]Additionally, an immediate effect has been observed following the application of PBM therapy. [10]In this study, it was observed that the duration of the effect of PBM therapy was found to be an average of six months for dental hypersensitivity and could be considered as a protocol to treat dental hypersensitivity in cases of MIH.

The use of the VAS scale was an essential instrument to evaluate pain in patients, as it is a personal and subjective

experience that can be influenced by the environment. There was a decrease in the pain scale score after the application of PBM, corroborating da Silva *et al*.[25] who reported a decrease in the intensity of pain measured by VAS in a patient with MIH. In addition to the cost-effectiveness and simplicity of the technique, the application of PBM has been shown to be effective in similar cases. Furthermore, the use of VAS proves to be a valuable tool for both treating and monitoring sensitivity in patients with MIH.

Conclusion

It can be concluded that PBM therapy using a low-power laser is an effective option for the treatment of MIH hypersensitivity and aims to control discomfort and pain, allowing a better quality of life for the patient. However, more studies are needed to develop a specific protocol for the use of lasers in patients with MIH.

Conflicts of Interest

All authors declare that they have no conflicts of interest regarding the publication of this article.

The authors declare that there was no financial support for carrying out these reports.

References

1. Weerheijm, K.L. Molar Incisor Hypomineralization (MIH): Clinical Presentation, Aetiology and Management. Dental Update. 2004;31(1):9-12.
2. Silva MJ, Scurrah KJ, Craig JM, Manton DJ, Kilpatrick N. Etiology of molar incisor hypomineralization - A systematic review. Community Dent Oral Epidemiol. 2016;44(4):342-53.
3. Bandeira Lopes L, Machado V, Botelho J, Haubek D. Molar-incisor hypomineralization: an umbrella review. Acta Odontol Scand. 2021;79(5):359-69.
4. Pessoa CP, Pion L, Reyes A, Matos R, Alencar CF, Novaes TF, Braga MM. Conservative approach for molar-incisor hypomineralization: a case report and 7-year follow-up. Gen Dent. 2018;66(3):e1-e4.
5. Sundfeld D, da Silva LMS, Kluppel OJ, Santin GC, de Oliveira RCG, Pacheco RR et al. Molar Incisor Hypomineralization: Etiology, Clinical Aspects, and a Restorative Treatment Case Report. Oper Dent. 2020;45(4):343–51.
6. Gevert MV, Soares R, Wambier LM, Ribeiro AE, Avais LS, de Souza JF, Chibinski ACR. How is the quality of the available evidence on molar-incisor hypomineralization treatment? An overview of systematic reviews. Clin Oral Investig. 2022;26(10):5989-6002.
7. Afzal SH, Skaare AB, Wigen TI, Brusevold IJ. Molar-Incisor Hypomineralisation: Severity, caries and hypersensitivity. J Dent. 2024;142:104881.
8. Fagrell TG, Lingström P, Olsson S, Steiniger F, Norén JG. Bacterial invasion of dentinal tubules beneath apparently intact but hypomineralized enamel in molar teeth with molar incisor hypomineralization. Int J Paediatr Dent. 2008;18(5):333-40.
9. Zhao D, Dong B, Yu D, Ren Q, Sun Y. The prevalence of molar incisor hypomineralization: evidence from 70 studies. Int J Paediatr Dent. 2018;28(2):170-79.
10. Lopes LB, Machado V, Mascarenhas P, Mendes JJ, Botelho J. The prevalence of molar-incisor hypomineralization: a systematic review and meta-analysis. Sci Rep. 2021;11(1):22405.
11. Muniz RSC, Carvalho CN, Aranha ACC, Dias FMCS, Ferreira MC. Efficacy of low-level laser therapy associated with fluoride therapy for the desensitisation of molar-incisor hypomineralisation: Randomised clinical trial. Int J Paediatr Dent. 2020;30(3):323-33.

12. Machado AC, Viana ÍEL, Farias-Neto AM, Braga MM, de Paula Eduardo C, de Freitas PM, Aranha ACC. Is photobiomodulation (PBM) effective for the treatment of dentin hypersensitivity? A systematic review. Lasers Med Sci. 2018;33(4):745-53.
13. Hagiwara S, Iwasaka H, Hasegawa A, Noguchi T. Pre-Irradiation of blood by gallium aluminum arsenide (830 nm) low-level laser enhances peripheral endogenous opioid analgesia in rats. Anesth Analg. 2008;107(3):1058-63.
14. Chow R, Armati P, Laakso EL, Bjordal JM, Baxter GD. Inhibitory effects of laser irradiation on peripheral mammalian nerves and relevance to analgesic effects: a systematic review. Photomed Laser Surg. 2011;29(6):365-81.
15. Harcke SJ, Rizzolo D, Harcke HT. G6PD deficiency: An update. JAAPA. 2019;32(11):21-6.
16. Raposo F, de Carvalho Rodrigues AC, Lia ÉN, Leal SC. Prevalence of Hypersensitivity in Teeth Affected by Molar-Incisor Hypomineralization (MIH). Caries Res. 2019;53(4):424-30.
17. Paschoal MAB, Costa HE, Santos-Pinto L, Ferreira MC. Photobiomodulation therapy for hypersensitivity associated with molar-incisor hypomineralization: a case report. Gen Dent. 2021;69(6):50-3.
18. Katz J, Melzack R. Measurement of pain. Surg Clin North Am. 1999;79(2):231-52.
19. Elhennawy K, Schwendicke F. Managing molar-incisor hypomineralization: A systematic review. J Dent. 2016;55:16-24.
20. Enax J, Amaechi BT, Farah R, Liu JA, Schulze Zur Wiesche E, Meyer F. Remineralization Strategies for Teeth with Molar Incisor Hypomineralization (MIH): A Literature Review. Dent J (Basel). 2023;11(3):80.
21. Inchingolo AM, Inchingolo AD, Viapiano F, Ciocia AM, Ferrara I, Netti A, Dipalma G, Palermo A, Inchingolo F. Treatment Approaches to Molar Incisor Hypomineralization: A Systematic Review. J Clin Med. 2023;12(22):7194.
22. Lygidakis NA, Garot E, Somani C, Taylor GD, Rouas P, Wong FSL. Best clinical practice guidance for clinicians dealing with children presenting with molar-incisor-hypomineralisation (MIH): an updated European Academy of Paediatric Dentistry policy document. Eur Arch Paediatr Dent. 2022;23(1):3-21.
23. Somani C, Taylor GD, Garot E, Rouas P, Lygidakis NA, Wong FSL. An update of treatment modalities in children and adolescents with teeth affected by molar incisor hypomineralisation (MIH): a systematic review. Eur Arch Paediatr Dent. 2022;23(1):39-64.
24. Praveen R, Thakur S, Kirthiga M, Narmatha M. Comparative evaluation of a low-level laser and topical desensitizing agent for treating dentinal hypersensitivity: A randomized controlled trial. J Conserv Dent. 2018;21(5):495-499.
25. da Silva FG, de Almeida SB, de Campos PH, Abrantes RM, de Oliveira AVA, Guaré RO, Diniz MB. Low-Level Laser Therapy for Management of Hypersensitivity in Molar-Incisor Hypomineralization and Oral Health-Related Quality of Life: Case Report. J Clin Pediatr Dent. 2022;46(2):107-111

Recibido 17/10/2024
Aceptado 04/01/2025
Correspondencia: Carolina Steiner-Oliveira, correo: csteiner@unicamp.br