

## Original Article

# Evaluation of the effect of green tea extract on postoperative pain management following surgical removal of impacted mandibular third molar

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## ABSTRACT

**Background:** Pain following surgical removal of impacted molars has remained a principal concern among practitioners. Since green tea has anti-inflammatory and anti-bacterial properties, the current study aimed to evaluate the efficacy of green tea extract local application in controlling postoperative pain following surgical extraction of the impacted mandibular third molar teeth.

**Materials and Methods:** In a double-blinded randomized controlled trial study with a split-mouth design, 32 patients underwent bilateral removal of impacted third molars in a 2-month time interval; afterward, the sterile gauzes impregnated with green tea extract and saline were applied randomly to the surgical sites. Postoperative pain was evaluated 6, 12, 24, and 48 h after surgery using a questionnaire based on the Visual Analog Scale (VAS) and the number of analgesics used after surgery. Data were subjected to exact and Chi-square tests with the significance level set at 0.05.

**Results:** There was a decrease in the mean scores of the VAS and the mean number of analgesic consumptions in the first 2 days after surgery. Chi-square test results showed a significant reduction in the VAS scores after applying the green tea extract only 6 and 12 h after surgery ( $P < 0.05$ ). Moreover, the number of analgesic consumptions was significantly lower in the green tea group compared to the control group.

**Conclusion:** Green tea extract may be an appropriate and safe choice for postoperative pain control after surgical extraction of the impacted mandibular third molar teeth.

**Key Words:** *Camellia sinensis*, green tea extract, Third molar, postoperative pain

Received: 26-Feb-2022  
Accepted: 05-Sep-2022  
Published: 14-Feb-2023

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## INTRODUCTION

One of the most commonly performed dental procedures is the surgical extraction of wisdom teeth.<sup>[1]</sup> The overall complication rate might be generally low and most complications are minor; however, as a frequent surgical procedure, the

morbidity of complications may be noticeable; as a result, identifying methods to control and reduce them is still a major concern for the clinicians; besides, not all complications are rare.<sup>[2-5]</sup> Pain is one of the most common complications of a wisdom tooth extraction

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**How to cite this article:** Etemadi Sh M, Haghghat A, Fattahi B, Tajmiri G, Alizargar J. Evaluation of the effect of green tea extract on postoperative pain management following surgical removal of impacted mandibular third molar. Dent Res J 2023;20:17.

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surgery caused by pain mediators released from the injured tissues. Pain begins after the anesthesia subsides and reaches its peak level during the 1<sup>st</sup> postoperative day.<sup>[6]</sup>

Pain management is done to completely prevent or decrease the discomfort to a more tolerable level with minimal side effects.<sup>[7]</sup> There are several pain relief protocols, none of which are ideal. The most common protocol for the elimination of postoperative pain is to administer nonsteroidal anti-inflammatory drugs (NSAIDs). Nonetheless, some side effects, including gastrointestinal bleeding, cardiovascular complications, and platelet dysfunction, are reported to be related to these drug generations.<sup>[8]</sup> One principal drawback of these medications is that they also inhibit the beneficial effects of prostaglandins, which can be hazardous for patients with underlying diseases or pregnant women.<sup>[9]</sup> Researchers are in search of the best alternative option regarding a safer drug profile and an acceptable efficacy.

Comfort *et al.* performed a clinical trial comparing the efficacy of three analgesic protocols and showed that diflunisal is superior to panadeine and etodolac concerning pain control following wisdom tooth extraction surgery with fewer side effects.<sup>[10]</sup>

It is claimed that chlorhexidine products can have analgesic effects on postoperative pain following oral surgeries. Haraji *et al.* showed that intra-alveolar application of 0.2% chlorhexidine in the form of bioadhesive gel not only reduces the risk of dry socket but also can control the postoperative pain in patients with or without dry socket following surgical removal of impacted mandibular wisdom teeth.<sup>[11]</sup>

Tea, a product made from the leaf and bud of the plant *Camellia sinensis*, is the second most consumed beverage worldwide and has been used medicinally for centuries in traditional Chinese medicine.<sup>[12]</sup> In recent years, considerable attention has been paid to the desirable health-promoting benefits of green tea. Anti-inflammatory, anti-arthritis, anti-bacterial, anti-angiogenic, anti-oxidative, antiviral, neuroprotective, and cholesterol-lowering effects are the most important beneficial properties of green tea consumption.<sup>[13,14]</sup> The active components of tea responsible for such biological effects are known to be catechins (known as polyphenols), including epigallocatechin gallate, which is a principal catechin compound available in tea extracts and is also the most active form in a variety of biological activities.<sup>[15]</sup>

Pain has long been recognized as a hallmark of inflammation and is especially relevant to the diagnosis of infection besides other signs, including swelling, erythema, warmth, and impairment of function. Besides, a bacterial infection is also a reason for severe postoperative pain.<sup>[16]</sup> Green tea mouthwash has also presented antimicrobial activity against the adherence of microorganisms to suturing materials; therefore, it can reduce the risk of surgical site infection.<sup>[17]</sup>

Nowadays, herbal medications have gained increasing popularity as an affordable and safe way to manage postoperative pain.<sup>[18]</sup> Jenabian *et al.* showed that *C. sinensis* – as an adjunct treatment for inflammatory periodontal diseases – can result in improvement of all periodontal indices, including gingival index, plaque index, and bleeding index.<sup>[19]</sup> Tafazoli Moghadam *et al.* have observed aloe vera and green tea mouthwash's analgesic effects after periodontal pocket surgery.<sup>[20]</sup> According to Eshghpour's study, using green tea mouthwash can reduce pain following wisdom tooth removal. Moreover, green tea contains certain forms of catechins with *in vitro* and *in vivo* antibacterial properties that make it an efficient tool for controlling both dental caries and periodontal diseases.<sup>[21]</sup> In a clinical trial performed by Behfarnia *et al.*, the efficacy of 15 min chewing two green tea gums per day for 3 weeks on the reduction of sulcus bleeding index and plaque index was studied in patients with generalized marginal gingivitis; as a conclusion, this method was regarded an effective tool for this purpose.<sup>[22]</sup>

However, at the time of performing the present study, there was no study investigating the local benefits of green tea extract concerning postoperative pain control after oral surgeries. Therefore, the present study aimed to evaluate the efficacy of the local application of green tea extract as a safe and affordable method in relieving the pain as well as investigating the effect of this herbal treatment on the prevalence of dry socket following surgical removal of impacted mandibular third molars.

## MATERIALS AND METHODS

Calculation of the sample size (32 patients and 64 samples, respectively) was done using the formula for comparison of two means with a minimum difference of 0.7 in Visual Analog Scale (VAS) pain score and the mean number of analgesics used and

the  $\alpha$ -error of 0.05 and  $1-\beta = 0.80$ . We carried out this randomized double-blinded controlled trial study with the split-mouth design on 32 patients referred to the Oral and Maxillofacial Surgery Section of the Dentistry Faculty of Isfahan University of Medical Sciences. None of the patients or surgeons were aware of the exact location of green tea extract-impregnated gauze used after surgery.

This study followed the Declaration of Helsinki on medical protocol and ethics, and the Regional Ethical Review Board of Isfahan University of Medical Sciences approved the study on May 15, 2018. Patient selection was done using the convenience sampling method. Before the intervention, informed consent was obtained from all participants. The unwillingness of the patient to continue participation in the study came into consideration. All patients' information was kept confidential in this study. This study is registered on the Iranian clinical trial registry website (#IRCT20131205015665N4).

We included patients with 18–30 years of age and bilateral mandibular third molar impaction with the same difficulty based on the spatial direction of the teeth, depth of impaction, and relationship with the ramus on preoperative panoramic radiographs:

- Mesioangular or vertical impaction
- Class B of Pell and Gregory classification: occlusal plane of the impacted tooth is between the occlusal plane and the cervical margin of the second molar
- Class 1, 2 classification: relationship of the impacted tooth to the anterior border of the ramus – there is sufficient space available between the anterior border of the ascending ramus and the distal aspect of the second molar for the eruption of the third molar.

Being discontent, using narcotics or opiates such as cocaine or ephedrine, known or suspected allergy to green tea products, being a lactating or pregnant woman, using analgesic drugs, receiving antibiotic or herbal medications during the last 1 month, having systemic disorders, and presence of any lesions on panoramic radiographs or any maxillofacial pain such as temporomandibular disorder, Myofascial Pain Dysfunction Syndrome (MPDS), and pulpitis were considered exclusion criteria. Each patient underwent two surgeries. The right and left teeth of each patient were allocated randomly to the study or control group, regarding the odd or even identification (ID) numbers that were assigned to the participants beforehand.

Then, demographic data (including age and gender), as well as the patient's phone number and address, were recorded. Known or suspected allergy to green tea products was also investigated.

All the surgeries were performed by an experienced surgeon using the same protocol: the povidone-iodine solution was applied to the surgical site; local anesthesia was achieved by 2% lidocaine with 1:80,000 epinephrine (Exir, Tehran, Iran) using inferior alveolar nerve block and long buccal injections; a mucoperiosteal envelop flap was then created using a standard incision; if needed, bone removal, tooth sectioning, and bone recontouring were performed as well by using a low-speed handpiece under sufficient irrigation with a sterile solution; following tooth removal socket irrigation with 60 ml of saline, the flap was sutured using 3–0 silk sutures.

Regarding the previously defined randomization, in one surgery, green tea extract-impregnated sterile gauze was applied to the surgical site (study group), whereas in the second surgery, normal saline-impregnated gauze, as a placebo, was applied (control group). These surgeries took place in a 2-month time interval, and both patients and surgeons were blinded to the type of applied gauze.

Iranian green tea was purchased from the market (Zarghani Company, Mashhad, Iran), and for the preparation of hydroalcoholic extract, 300 g of the green tea powder was macerated by 1500 ml of ethanol 70% (v/v) for 72 h. The extract was then shaken and filtered. The solvent was removed in a vacuum evaporator to obtain a semi-solid extract and was placed in an oven at 60°C for 72 h. High-performance liquid chromatography was then used for assessing the phenolic compounds in the green tea extract.

Patients were instructed not to take any painkillers or narcotics 12 h before the procedure. At the end of the surgery, patients were given 10 Advalgin (Ibuprofen Lysine 400 mg) tablets and told to use them as the only medication for pain relief. They also were instructed not to drink green tea beverages 48 h after the operation. Respectively, 6, 12, 24, and 48 h after surgery, they were asked about the presence and intensity of pain on the surgical site in a phone call using a VAS which is a sensitive and reliable tool to evaluate the pain following surgical extraction of impacted molars.<sup>[23]</sup>

On the 3<sup>rd</sup> day after the operation, patients were examined by the surgeon for any signs of dry

socket. Patients reporting the consumption of other medications during the study period were excluded from the study.

The decrease in the VAS pain scores, as well as the number of consumed analgesics, was calculated for each patient by subtracting the score of pain in the green tea group from the control group. The statistical method used in this study was descriptive analytics and exact and Chi-square tests performed with the SAS statistical software version 9.4 (SAS Institute, Cary, NC, USA).

## RESULTS

A total of 32 patients met the inclusion criteria: 14 men (43.8%) and 18 women (56.3%). One patient was excluded since she did not come back for the second surgery during the study period. The mean age of participants was  $21.53 \pm 2.5$  with a minimum and maximum age of 18 and 28, respectively. The mean number of analgesics used during 2 postoperative days was  $5.53 \pm 2.59$  in the control group and  $4.25 \pm 1.66$  in the study group.

The type of impaction of the mandibular third molars was not significantly different in the case and control groups ( $P > 0.05$ ). The most common type of impaction was mesioangular in both the study and control groups. Seventeen patients (53.13%) had bilateral mesioangular impaction; on the other hand, two participants (6.25%) were detected with bilateral vertical impaction. In 13 patients (40.63%), the type of impaction was different on both sides.

The mean score of the VAS of pain in 6-, 12-, 24-, and 48-h time intervals following surgical extraction of the mandibular third molars decreased in the green tea group compared to the saline group. The mean number of analgesic consumptions also decreased in the study group in comparison to the control group [Table 1]. Figures 1-5 demonstrate the decreases in the VAS scores of pain as well as the number of analgesics used for each patient.

After 6, 12, 24, and 48 h, 17 patients (53.13%), 18 patients (56.25%), 17 patients (53.13%), and 9 patients (28.13%) had lower VAS scores when they used green tea compared to when they did not. To further evaluate the distribution of VAS pain scores with and without green tea, the Chi-square test showed that the differences in VAS pain scores were significant after using green tea at 6- and 12-h

**Table 1: Common analgesic compounds detected in green tea extract using high-performance liquid chromatography**

Structure	Percentage weight (mg/g DW)	Retention time (min)	Concentration (mg/L)
Catechin	66.27	8.3	1656.93
Gallic acid	435.07	3.3	10876.99
Caffeic acid	688	11.6	17200
p-Coumaric acid	21.68	15.6	542
Vanillin	13.24	13.5	331.06
Eugenol	2.35	23.7	58.92
Rosmarinic acid	7.60	19.2	190.21

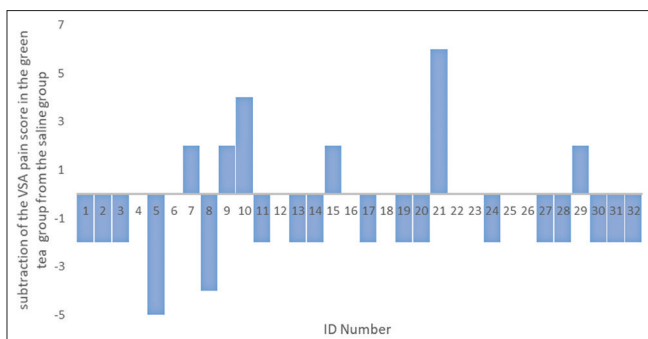
time intervals ( $P < 0.05$ ), while these differences were not statistically significant at 24- and 48-h intervals ( $P > 0.05$ ). Regarding the number of analgesics used, 19 (59.38%) patients recorded fewer analgesic consumptions following the administration of green tea extract, which is considered statistically significant ( $P < 0.05$ ) [Table 2].

## DISCUSSION

The results of the present study showed that local administration of the green tea extract may have positive effects on early VAS pain scores (6 and 12 h after surgery) and the total number of required painkillers used during the 1<sup>st</sup> postoperative day following surgical removal of the impacted mandibular third molar teeth.

In a randomized cross-over controlled trial performed by Tafazoli Moghadam *et al.*, postoperative pain following pocket reduction surgery was evaluated in 45 patients aged 25–50 years and observed that after administration of aloe vera and green tea mouthwash for 10 days, the score of the Numeric Pain Rating Scale was significantly lower in only the 1<sup>st</sup> postoperative day.<sup>[20]</sup> The probable explanation for this short-term effect may be the rinsing effect of saliva, which can interfere with the actual local efficacy of the mouthwash. Furthermore, the nature of the inflammation in periodontal diseases can be different from the inflammation that arises from surgical trauma to the surgical site. The principal source of inflammation and subsequent pain would be the clean surgical trauma in third molar surgical extraction, which is deep compared to the periodontal pathogens.

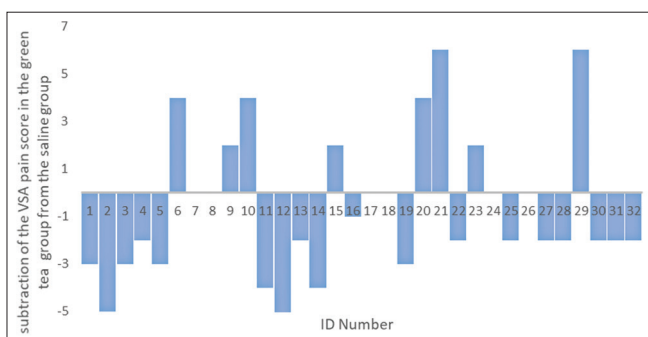
In a similar study by Eshghpour *et al.*, they evaluated the effectiveness of green tea mouthwash on postoperative pain control after surgical removal of



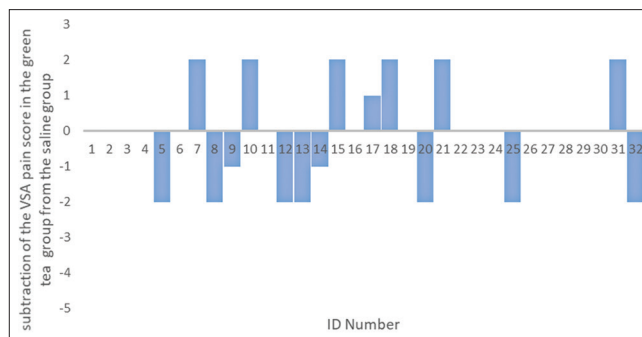
**Figure 1:** Changes in VAS pain scores in each patient after 6 h (comparison between when used green tea and when did not, green tea minus no green tea), VAS: Visual Analog Scale.



**Figure 3:** Changes in VAS pain scores in each patient after 24 h (comparison between when used green tea and when did not, green tea minus no green tea), VAS: Visual Analog Scale.



**Figure 2:** Changes in VAS pain scores in each patient after 12 h (comparison between when used green tea and when did not, green tea minus no green tea), VAS: Visual Analog Scale.



**Figure 4:** Changes in VAS pain scores in each patient after 48 h (comparison between when used green tea and when did not, green tea minus no green tea), VAS: Visual Analog Scale.

impacted mandibular third molars. Results showed a significant difference in VAS pain scores following the use of this mouthwash in the postoperative days of 3–7; moreover, the number of analgesics used after surgery was significantly lower in the study group,<sup>[21]</sup> which is consistent with the outcomes of our study.

In a double-blind clinical trial study performed by Yaghini *et al.* on 60 patients, comparing two herbal types of mouthwash to chlorhexidine mouthwash according to the periodontal indices including plaque index, gingival index, bleeding on probing, and dental stain index; the results showed a reducing effect of aloe vera-green tea and chlorhexidine mouthwashes on plaque index, gingival index, and bleeding on probing; although, the difference was not statistically significant. The difference was significant in the dental stain index for aloe vera mouthwash; on the other hand, the Matrica mouthwash had a significant effect on plaque and gingival indices compared to other products. Furthermore, the difference in the dental stain index was also significant for Matrica mouthwash in comparison to the chlorhexidine mouthwash. Finally, the difference in bleeding on probing was not significant in any of

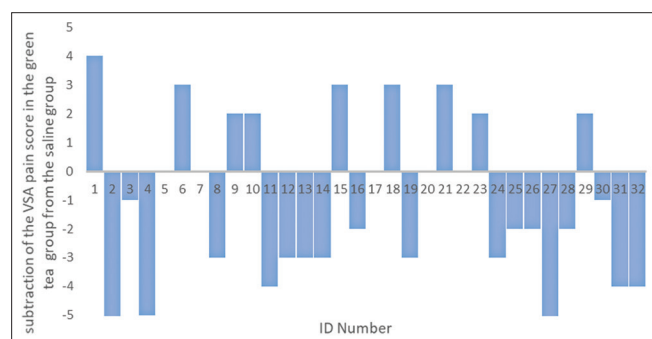
the groups. They concluded that these herbal products, including green tea mouthwash, can be clinically effective due to their anti-inflammatory and antiplaque properties.<sup>[24]</sup> Similarly, Priya *et al.* evaluated the decrease in similar periodontal indices plus tongue stain 15 and 30 days following using green tea mouthwash compared to the chlorhexidine mouthwash. They showed that green tea mouthwash could significantly decrease bleeding on probing compared to the chlorhexidine mouthwash; the differences in dental and tongue stains were not significant between the two groups.<sup>[25]</sup> These contradictory results may be due to the nature of the herbal mouthwashes, which was pure green tea in Priya’s study compared to green tea combined with aloe vera in Yaghini’s study.

The concept of the efficacy of green tea mouthwash on periodontal status is supported in a systematic review by Gartenmann *et al.*<sup>[26]</sup> They showed that green tea mouthwash had similar plaque index reducing effects to chlorhexidine mouthwash; consequently, it may be considered an alternative for chlorhexidine mouthwash, especially in long-term use.

**Table 2: Distribution of changes in Visual Analog Scale scores and analgesics used (comparison between when used green tea and when did not, green tea minus no green tea)**

Time after surgery	Total		Age		Sex		
	n (%)	P	Mean±SD	P	Male, n (%)	Female, n (%)	P
6 h							
No difference in VAS score	9 (28.13)	0.048	23±2.82	0.079	4 (44.44)	5 (55.56)	0.896
Increase in VAS score	6 (18.75)		21.66±3.32		2 (33.33)	4 (66.67)	
Decrease in VAS score	17 (53.13)		20.70±1.64		8 (47.06)	9 (52.94)	
12 h							
No difference in VAS score	6 (18.75)	0.022	21.16±0.75	0.652	2 (33.33)	4 (66.67)	0.317
Increase in VAS score	8 (25)		22.25±3.19		2 (25)	6 (75)	
Decrease in VAS score	18 (56.25)		21.33±2.58		10 (55.56)	8 (44.44)	
24 h							
No difference in VAS score	7 (21.88)	0.058	22±2.88	0.361	4 (57.14)	3 (42.86)	0.797
Increase in VAS score	8 (25)		22.37±3.24		3 (37.50)	5 (62.50)	
Decrease in VAS score	17 (53.13)		20.94±1.88		7 (41.18)	10 (58.82)	
48 h							
No difference in VAS score	16 (50)	0.123	22.06±2.67	0.462	9 (56.25)	7 (43.75)	0.337
Increase in VAS score	7 (21.88)		21.28±2.75		3 (42.86)	4 (57.14)	
Decrease in VAS score	9 (28.13)		20.77±1.98		2 (22.22)	7 (77.78)	
Analgesic							
No difference in numbers	5 (15.63)	0.006	21.20±1.095	0.655	2 (40)	3 (60)	0.485
Increase in numbers	8 (25)		22.25±3.19		2 (25)	6 (75)	
Decrease in numbers	19 (59.38)		21.31±2.49		10 (52.63)	9 (47.37)	

VAS: Visual Analog Scale, SD: Standard deviation



**Figure 5:** Changes in the number of analgesics used in each patient during the 2 postoperative days (comparison between when used green tea and when did not, green tea minus no green tea).

It is worthy to note that due to the probable unknown side effects of green tea mouthwash, heterogeneous data, and lack of sufficient controlled clinical trials with longer follow-ups, there is a high risk of bias, and therefore, interpretation should be performed with caution.<sup>[26]</sup> It seems that the results of the abovementioned studies are consistent with the outcomes of our work since the anti-inflammatory properties of green tea mouthwash can lead to analgesic effects on postoperative pain following surgical extractions in which inflammation plays an important role. However, the reduced number of painkillers used by patients following

the administration of green tea products shows comparable analgesic effects of green tea mouthwash to chlorhexidine mouthwash. As a result, it seems that green tea products may be considered superior regarding financial issues in addition to the medical side effects of chemical drugs such as NSAIDs and chlorhexidine.

In a randomized controlled trial study, Soltani *et al.* evaluated the effect of green tea extract on postoperative pain following surgical extraction of the impacted mandibular third molar. The outcomes showed that it may reduce socket bleeding and oozing following the surgery.<sup>[27]</sup> Our study with a similar design showed additional analgesic properties for green tea extract.

Variable protocols in different clinical trials have been administered to control the postoperative pain following surgical extraction of the impacted mandibular third molar. Khorshidi *et al.* considered socket irrigation with bupivacaine after surgery an effective way for reducing postoperative pain. They showed significant decreases in the pain levels at 1-, 6-, 12-, and 24-h time intervals after the surgery.<sup>[28]</sup> However, the administration of bupivacaine might not be a safe choice for all patients; besides, it might not be financially affordable in all situations. In another

study done by Shaban *et al.*, evaluating the frequency and risk of dry socket following the application of the 0.2% chlorhexidine gel was decreased.<sup>[29]</sup> The results of our study showed that such properties can be expected from green tea extract; besides financial issues, green tea may be a better choice and a safe alternative to chlorhexidine products. In a similar study performed by Fallahi *et al.*, it was observed that aloe vera mouthwash can significantly reduce postoperative complications, especially pain and swelling; nonetheless, this difference was only significant on the 3<sup>rd</sup> postoperative day after wisdom tooth extraction.<sup>[30]</sup> This can be related to the different chemical properties of aloe vera compared to green tea. Moreover, the rinsing properties of mouthwash in comparison to the local application of green tea extract on the surgical site can explain the delayed onset of analgesic effects of aloe vera mouthwash in contrast to the early pain relief related to the green tea-impregnated gauze.

Our study had certain strengths and limitations. Regarding the split-mouth and consequently the self-control design of our study, the effects of confounding variables, including but not limited to age and gender, are minimized. Other confounding factors, including the difficulty of surgery, operation time, and surgeon experience, were also controlled by having just one experienced surgeon performing all surgeries. Patients' poor cooperation was predicted by adding 16% to the final sample size calculation. Another potential challenge was the possibility of lacking proper pain relief by just applying green tea extract on the surgical site; therefore, ten tabs of ibuprofen 400 mg were prescribed for the patients in case they had postoperative pain in need of analgesics. Instruction of the patients was also done immediately after the operation to prevent possible excessive bleeding and reduce the risk of dry socket.

## CONCLUSION

The results of our study showed that green tea-impregnated gauze is an effective and safe choice for postoperative pain control and reduces the mean number of painkillers used by patients following surgical extraction of the impacted mandibular third molar teeth.

### Financial support and sponsorship

This study was funded by the Research Council of the Isfahan University of Medical Sciences (Grant #397067).

### Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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