Evaluation of the local inflammatory stress response and pain mediator secretion after impacted wisdom tooth extraction with high-speed turbine drill combined with original luxator

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ABSTRACT
Objective: To study the local inflammatory stress response and pain mediator secretion after impacted wisdom tooth extraction with high-speed turbine drill combined with original luxator.
Methods: Patients who received impacted wisdom tooth extraction in the First People’s Hospital of Yunnan Province between March 2014 and June 2017 were selected as the research objects and randomly divided into the observation group who accepted impacted wisdom tooth extraction with high-speed turbine drill combined with original luxator and the control group who accepted impacted wisdom tooth extraction with traditional chisel. The contents of inflammatory mediators, stress mediators and pain mediators in gingival crevicular fluid were measured before surgery and 3 days after surgery.
Results: Three days after surgery, PTX3, ICAM1, MPO, PGE2, PPAR γ, ROS, MDA, 5-HT, CGRP, SP, Gal and ATP contents in gingival crevicular fluid of both groups were higher than those before surgery whereas GPx and T-AOC contents were significantly lower than those before surgery, and PTX3, ICAM1, MPO, PGE2, PPAR γ, ROS, MDA, 5-HT, CGRP, SP, Gal and ATP contents in gingival crevicular fluid of observation group were lower than those of control group whereas GPx and T-AOC contents were significantly higher than those of control group.
Conclusions: The impacted wisdom tooth extraction with high-speed turbine drill combined with original luxator can reduce the local inflammatory stress response and inhibit the secretion of pain mediators.

1. Introduction

Impacted wisdom tooth is the wisdom teeth that grows in inappropriate position and is not able to erupt to normal bite position, which will not only affect the patient’s chewing function, but also can increase the incidence of periodontal inflammation, and it is mainly treated by clinical impacted wisdom tooth extraction[1]. Traditional way of impacted wisdom tooth extraction is to remove the resistance by chisel or root division, and then extract the impacted tooth. The operation is simple with exact effect of impacted tooth extraction, but the tapping of tooth extraction hammer on local tissue can cause large vibration and damage, leading to excessive inflammatory response and stress response in periodontial tissue. At the same time, it will also increase the secretion of a variety of pain mediators and cause pain after tooth extraction[2,3]. High-speed turbine drill and original luxator are the minimally invasive devices that have been used for impacted tooth extraction in recent years, high-speed turbine drill is used as first to separate dental crown and root, and then the original luxator is inserted in the tooth clearance to cut the ligament and extract the impacted tooth[4]. It has been reported that the postoperative pain perception and facial swelling are relatively lighter after high-speed turbine drill combined with original luxator is adopted to extract the impacted wisdom tooth. In the following studies, we specifically analyzed the local inflammatory stress response and pain mediator secretion after impacted wisdom tooth extraction with high-speed turbine drill combined with original luxator.
2. Materials and methods

2.1. General case information

Patients who received impacted wisdom tooth extraction in the First People's Hospital of Yunnan Province between March 2014 and June 2017 were selected as the research objects, all the patients were in line with the indications for impacted wisdom tooth extraction, and the patients combined with tooth extraction contraindications were eliminated. A total of 122 patients were enrolled and divided into two groups by random number table method, each with 61 cases. Observation group accepted impacted wisdom tooth extraction with high-speed turbine drill combined with original luxator, including 36 males and 25 females who were 14-42 years old; control group accepted impacted wisdom tooth extraction with traditional chisel, including 33 males and 28 females who were 15-45 years old. There was no significant difference in the general data between the two groups (P>0.05).

2.2. Impacted wisdom tooth extraction

Both groups of patients underwent X-ray and oral routine examination before the operation to confirm the location of the impacted tooth, its relationship with the surrounding tissues and its connection with inferior alveolar nerve canal and then extract the impacted wisdom tooth. The oral cavity was disinfected with 1% iodine, and 2% lidocaine epinephrine solution was used for block anesthesia of the lingual nerve, inferior alveolar nerve and buccal nerve, and the impacted tooth was exposed after the tissue around was incised. Observation group was treated by high-speed turbine dental drill to take out the bone tissue covering the tooth surface and then separate the roots and crowns, and then original luxator was inserted between root and alveolar bone, cut the paradontium and extract the tooth; control group was treated by conventional scheme for tooth extraction, dental elevator was placed between the root and the alveolar bone after chisel, then tooth extraction hammer was used to tap on the dental elevator, and the dental elevator was pried to extract the root after it was wedged to enough depth.

2.3. Gingival crevicular fluid index detection

Before surgery and 3 d after surgery, gingival crevicular fluid samples were collected respectively, enzyme-linked immunosorbent assay kits were used to determine PTX3, ICAM1, MPO, PGE2, PPARγ, 5-HT, CRGP, SP, Gal and ATP content, and radioimmunoprecipitation kits were used to determine GPx, T-AOC, ROS and MDA contents.

2.4. Statistical analysis

SPSS 200 software was used for the data input and t test of data between two groups before and after treatment, and P<0.05 showed that the differences in test results were statistically significant.

3. Results

3.1. Inflammatory mediator contents in gingival crevicular fluid

Before surgery and 3 d after surgery, analysis of inflammatory mediators PTX3, ICAM1, MPO and PGE2 contents in gingival crevicular fluid between two groups of patients was as follows: PTX3, ICAM1, MPO and PGE2 contents in gingival crevicular fluid were not significantly different between two groups of patients before surgery; 3 d after surgery, PTX3, ICAM1, MPO and PGE2 contents in gingival crevicular fluid of both groups were higher than those before surgery, and PTX3, ICAM1, MPO and PGE2 contents in gingival crevicular fluid of observation group were lower than those of control group (Table 1).

3.2. Stress mediator contents in gingival crevicular fluid

Before surgery and 3 d after surgery, analysis of stress mediators PPARγ (ng/mL), GPx (U/L), T-AOC (U/L), ROS (U/L) and MDA (μmol/L) contents in gingival crevicular fluid between two groups of patients was as follows: PPARγ, GPx, T-AOC, ROS and MDA contents in gingival crevicular fluid were not significantly different.

Table 1.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Time</th>
<th>PTX3</th>
<th>ICAM1</th>
<th>MPO</th>
<th>PGE2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>61</td>
<td>Before</td>
<td>1.83±0.24</td>
<td>98.51±11.92</td>
<td>1.41±0.18</td>
<td>74.85±9.39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>treatment</td>
<td>2.91±0.46*</td>
<td>135.62±16.87*</td>
<td>2.28±0.35*</td>
<td>103.41±14.85*</td>
</tr>
<tr>
<td>Control</td>
<td>61</td>
<td>Before</td>
<td>1.88±0.26</td>
<td>99.12±10.89</td>
<td>1.45±0.22</td>
<td>75.23±7.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>treatment</td>
<td>4.52±0.71*</td>
<td>193.85±25.83*</td>
<td>3.52±0.57*</td>
<td>162.92±20.35*</td>
</tr>
</tbody>
</table>

* comparison of inflammatory mediator contents before and after treatment within group, P<0.05; † comparison of inflammatory mediator contents between observation group and control group after treatment, P<0.05.
between two groups of patients before surgery; 3 d after surgery, PPARγ, ROS and MDA contents in gingival crevicular fluid of both groups were higher than those before surgery whereas Gpx and T-AOC contents were significantly lower than those before surgery, and PPARγ, ROS and MDA contents in gingival crevicular fluid of observation group were lower than those of control group whereas Gpx and T-AOC contents were significantly higher than those of control group (Table 2).

### 3.3. Pain mediator contents in gingival crevicular fluid

Before surgery and 3 d after surgery, analysis of pain mediators 5-HT (ng/mL), CGRP (ng/mL), SP (ng/mL), Gal (nmol/mL) and ATP (nmol/mL) contents in gingival crevicular fluid between two groups of patients was as follows: 5-HT, CGRP, SP, Gal and ATP contents in gingival crevicular fluid were not significantly different between two groups of patients before surgery; 3 d after surgery, 5-HT, CGRP, SP, Gal and ATP contents in gingival crevicular fluid of both groups were higher than those before surgery, and 5-HT, CGRP, SP, Gal and ATP contents in gingival crevicular fluid of observation group were lower than those of control group (Table 3).

### 4. Discussion

The traditional method of impacted wisdom tooth extraction mainly uses the lever principle and wedge force principle to loosen the impacted teeth and then remove them through the chisel and diastema increase by hammer tapping. It is easy to operate, but causes heavy mechanical damage and will lead to significant postoperative tooth fossa pain and facial swelling. Also, there will be an occurrence risk of alveolar bone fracture, inferior alveolar nerve injury and other serious complications[5]. In addition, the tapping of tooth extraction hammer during tooth extraction will bring a great psychological burden to the patient and aggravate the patient's fear and anxiety. High-speed turbine drill and original luxator are the minimally invasive devices that have been used to extract impacted wisdom teeth in recent years, high-speed turbine dental drill is used to remove the resistance around the impacted wisdom teeth, and original luxator is used to enter the diastema and cut the ligament to make the impacted wisdom teeth easily extracted. Existing clinical studies have confirmed that compared with traditional way of impacted wisdom tooth extraction, the combination of high-speed turbine drill and original luxator for impacted wisdom tooth extraction can reduce postoperative pain and facial swelling, as well as the incidence of complications under the premise of ensuring the efficacy of impacted wisdom tooth extraction[6,7]. However, there is no research on the superiority of high-speed turbine drill combined with original luxator in the trauma degree of impacted wisdom tooth extraction from the molecular level.

During impacted wisdom tooth extraction, the local tissue injury can cause the excessive activation of inflammatory response and excessive secretion of various inflammatory mediators[8]. PTX3 is a pro-inflammatory factor secreted by the mononuclear macrophages, which can activate inflammatory response through the activation of downstream NF-κB[9]; ICAM1 is the cytokine that mediates intercellular adhesion, and can promote the various inflammatory cells to adhere to local inflammatory site and mediate the amplification of inflammatory response[9]; PGE2 is the peroxide released during the activation of neutrophils, and the neutrophils extensively synthesize and secrete PGE2 during the activation of inflammatory reaction[10]; COX2 catalyzes the metabolism of arachidonic acid, and it can increase the permeability of local microcirculation and
promote local infiltration of inflammatory cells[12]. The analysis of changes in the contents of above inflammatory mediators in gingival crevicular fluid between the two groups of patients before and after operation showed that PTX3, ICAM1, MPO and PGE2 contents in gingival crevicular fluid of both groups 3 d after surgery were higher than those before surgery, and PTX3, ICAM1, MPO and PGE2 contents in gingival crevicular fluid of observation group were lower than those of control group 3 d after surgery. It means that impacted wisdom tooth extraction with both high-speed turbine drill combined with original luxator and traditional way will cause different degrees of trauma and increased secretion of postoperative inflammatory mediators in gingival crevicular fluid, and high-speed turbine drill combined with original luxator causes less inflammation and trauma than traditional way.

The activation of the inflammatory response after impacted wisdom tooth extraction can further lead to overproduction of oxygen free radicals and overactivation of oxidative stress in local tissues. ROS is an important type of oxygen free radical in the process of oxidative stress reaction activation in periodontal tissue, which is with a strong oxidative activity, and can have oxidizing reaction with the lipid in local tissue, leading to massive generation of MDA and also oxidative damage to the tissue[13,14]. PPARγ is a transcription factor that plays an antioxidant role in oxidative stress, and it activates gene expression by combining the response elements in the upstream of the target gene promoter; antioxidant enzyme GPx is an important target gene regulated by PPARγ, it is increasingly generated in the process of oxidative stress, but it will also be constantly consumed by excessively generated ROS, its content decreases, and the T-AOC is weakened[15]. The analysis of the changes in the contents of above stress mediators in gingival crevicular fluid between the two groups of patients before and after operation showed that PPARγ, ROS and MDA contents in gingival crevicular fluid of both groups 3 days after surgery were higher than those before surgery whereas GPx and T-AOC contents were significantly lower than those before surgery. PPARγ, ROS and MDA contents in gingival crevicular fluid of observation group were lower than those of control group whereas GPx and T-AOC contents were significantly higher than those of control group 3 days after surgery. It means that impacted wisdom tooth extraction with both high-speed turbine drill combined with original luxator and traditional way will cause different degrees of stress response and significant change in postoperative stress mediators in gingival crevicular fluid, and high-speed turbine drill combined with original luxator causes less stress response than traditional way.

Local pain is a major complication after the impacted wisdom tooth extraction. On the one hand, the activation of local inflammatory reaction and oxidative stress response has algesic activity; on the other hand, the trauma of local operation can increase the abnormal secretion of various pain mediators. 5-HT can stimulate nociceptors by acting on TRPV1, which induces pain perception. CGRP is a polypeptide with vasodilation effect, which can act on peripheral nervous system and enhance pain response[16]; SP and Gal are neuropeptides with pain signal transduction effect, which can reduce the excitation threshold of nerve fibers and promote the conduction of pain signals[17]; ATP is the mitochondrial oxidative phosphorylation product, which can be combined with the receptor P2X3 to promote the generation and transmission of pain signals. The analysis of the changes in the contents of above pain mediators in gingival crevicular fluid between the two groups of patients before and after operation showed that 5-HT, CGRP, SP, Gal and ATP contents in gingival crevicular fluid of both groups 3 days after surgery were higher than those before surgery, and 5-HT, CGRP, SP, Gal and ATP contents in gingival crevicular fluid of observation group were lower than those of control group 3 d after surgery. It means that impacted wisdom tooth extraction with both high-speed turbine drill combined with original luxator and traditional way will cause different degrees of pain and increased secretion of postoperative pain mediators in gingival crevicular fluid, and high-speed turbine drill combined with original luxator causes less pain than traditional way.

It can be concluded that the high-speed turbine dental drill combined with original luxator for impacted wisdom tooth extraction is less traumatic than traditional way, and it can significantly reduce the postoperative inflammatory stress response and suppress the secretion of pain mediators in local tissue.

References

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