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Sagittal Split Osteotomy for Removal of Deeply Impacted Third Mandibular Molars. A Prospective Case-Series Study

Abstract:

Study design: prospective and descriptive case – series.
Objective: to analyze outcomes, and complications of sagittal split osteotomy (SSO) for removal of deeply impacted third mandibular molars.

Methods: 8 subjects with deeply impacted third mandibular molars with an intimate relationship between the inferior alveolar nerve (IAN) and the dental roots were included. All subjects were treated with SSO to remove the deeply impacted third molar. The outcomes were evaluated at 3, 6 and 12 months after surgery, clinically and radiographically.

Outcomes: 6 subjects (75 %) had transient neurosensory disturbance (ND), with full recovery between 6 and 12 months. 2 patients (25%) had a non-disabling hypoesthesia at 12 months of follow up. It was necessary to remove the osteosynthesis material due to infection in one patient (12.5%). No other complication was observed. Radiographic signs of bone healing were evident at 6 months after surgery, without bone grafting materials.

Conclusions: SSO is a safe method for removing deeply impacted third mandibular molars and associated lesions. Nevertheless, additional studies with a larger sample are necessary to confirm these results

Key Words: sagittal split osteotomy; deeply impacted third mandibular molar; inferior alveolar nerve injury;third molars extraction; iatrogenic mandibular fracture; third molar extractions complications

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Abbreviations

SSO : sagittal split osteotomy
IAN : inferior alveolar nerve
ND : neurosensory disturbances
CBO : conventional buccal ostectomy
BCT : buccal corticotomy technique
IMF : iatrogenic mandibular fracture
CBCT : cone beam computed tomography

Introduction

The management of the deeply impacted third mandibular molars represents a significant challenge, especially considering the surgical volume. Infection, damage to adjacent teeth and associated lesion such as cysts or tumors are the typical indication for third molar removal. In addition, there is no international consensus or guidelines on this subject. [1,2,3]

Many different surgical techniques have been described for removal of deeply impacted mandibular molars, such as conventional buccal ostectomy (CBO), buccal corticotomy technique (BCT), lingual split, coronectomy, and extraoral access.[1,2] However, each of these methods have limitations and disadvantages such as, lack of visibility, bone loss, damage to the lingual and inferior alveolar nerve (IAN), iatrogenic mandibular fracture (IMF), damage to adjacent teeth and potential risk of injury to the marginal mandibular branch of the facial nerve for extraoral approach.[2]

Previous reports indicate an incidence of IAN injury during removal of third mandibular molars from 0.5 to 8%, with permanent neurologic sequelae found in 0.01 to 2% of the cases [4,5]. Other studies had demonstrated even higher risk with CBO.2 Furthermore, IMF after the removal of impacted third molars, have been reported to be more frequent by CBO, due to an excessive bone removal and in patients aged over 20 years.[6]

Sagittal split osteotomy (SSO) could be an alternative approach for removal of deeply impacted third mandibular molars to minimize risk of complications. SSO was first described by Trauner and

Obwegeser[7] for dentofacial deformity correction in 1957. Over the years the technique has been modified by Dal Pont,[8] Hunsuk,[9] Epker,[10] Bell11 and Arnett12 among others. SSO for intraosseous lesions removal was first described by Rittersma et al.[13]Afterwards, [11]
studies have demonstrated that this approach could be effective for that purpose.[14, 15, 16, 17, 18,19, 20, 21, 22, 23, 24]. Additionally, other studies have reported the use of SSO for deeply impacted third mandibular molars removal, as well as for IAN decompression after nerve injury due to endodontic treatment or implant placement. [1, 2, 25, 26] The aim of this study is to analyze outcomes and complications of SSO for removal of deeply impacted third mandibular molars, and to present rationale and specific indications of this technique.

Materials And Methods

We designed a prospective case-series study that followed the Declaration of Helsinki on medical protocol and ethics. This study included 8 patients referred to our office between 2015 and 2022, for surgical removal of deeply impacted third mandibular molars. All patients had a deeply impacted third mandibular molar, some of them, with associated lesion such as cyst or tumor and/or signs of infection, with or without pain (table 1).

Patient	Gender	Age	Indication for surgery	Rubio - Mombrú Classification	Hp diagnosis	Follow-up (months)	Complication
1	F	51	Left 3ed M, infection, pain, associated lesion	2/A	Dentigerous cyst	19	None
2	M	50	Left 3ed M, associated lesion	2/B	Odontogenic cyst	30	Non-disabling hypoesthesia, osteosynthesis mat. infection
3	M	33	Right 3ed M, infection, pain, associated lesion	1/B	Dentigerous cyst	12	None
4	M	31	Right 3ed M, associated lesion	3/A	Dentigerous cyst	9	None
5	M	35	Right 3ed M, associated lesion	2/A	Odontogenic fibroma	9	None
6	F	55	Left 3ed M, associated lesion	2/C	Dentigerous cyst	12	Non-disabling hypoesthesia
7	M	40	Right 3ed M, associated lesion	3/A	Dentigerous cyst	10	None
8	M	29	Right 3ed M, associated lesion	1/B	Dentigerous cyst	6	None

Table 1: Patients sample.

3ed M, *third molar*. HP diagnosis, *histopathologic diagnosis*. Osteosynthesis mat., *osteosynthesis material.*

An impacted third mandibular molar was considered "deeply" if it had at least one of the three following features in panoramic radiograph: 1) the upper point of the third molar´s crown was inferior to the cementum – enamel junction of the second molar, 2) the distance between the lowest point of the third molar´s roots and the inferior border of the mandible was less than 10 mm, 3) the most anterior point of the crown was behind to a tangential vertical line of the anterior border of the mandible (coronoid process). (Figure 1)

Figure 1: Left (A) and right (B) deeply impacted third mandibular molar with associated lesions.

The panoramic radiologic signs review the presence of at least 1 of the 7 radiologic signs, as reported by Rood and Shehab26. Each patient included in the sample was assessed with cone beam computed tomography (CBCT) scans images before surgery (Fig 2), with special focus on 1) the position of the IAN in relation to the third molar or associated lesion 2) the distance between the tip of the dental roots and the inferior border of the mandible 3) the integrity of bone cortical plates (buccal and lingual) 4) the presence or absence of bone between the mandibular canal and the dental roots or the associated lesion (table 2).

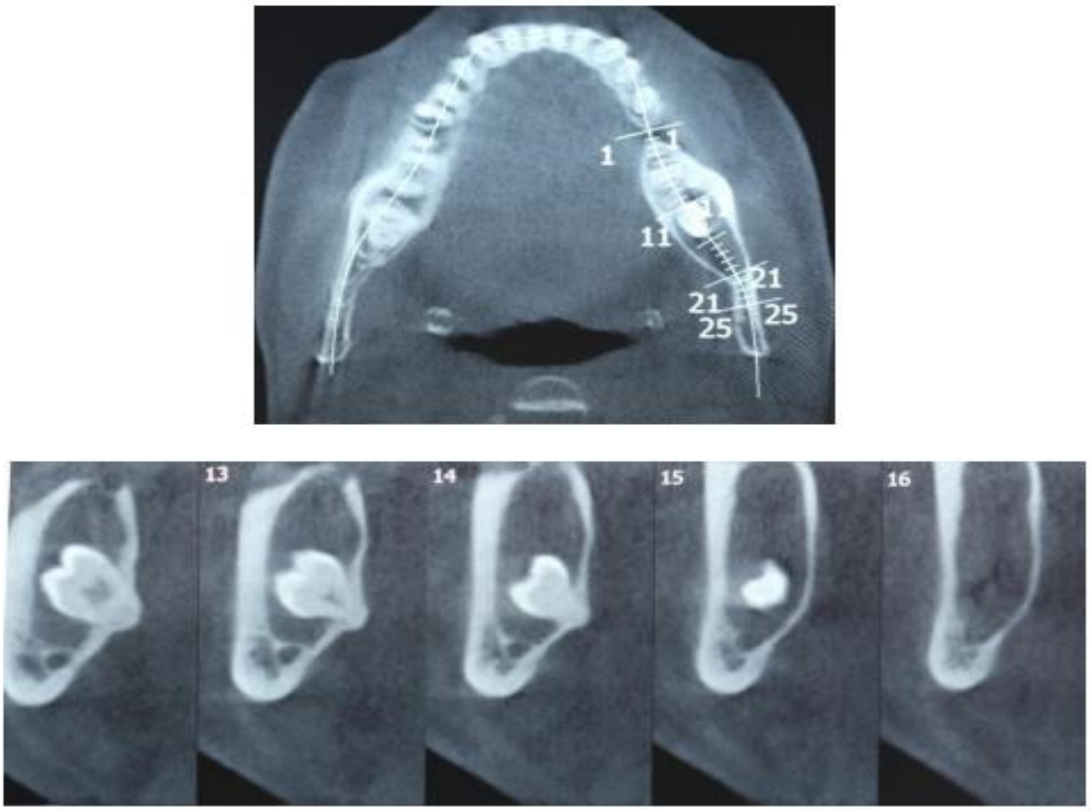

Figure 2: CBCT scan images of a deeply impacted third mandibular molar with dentigerous cyst

Patient	Ian position	Thickness of the inferior border of the mandible	Bone cortical Plate eroded	Mc Eroded
1	Lingual	Less than 5 mm	Lingual	Yes
2	At 3ed M level	Less than 5 mm	Lingual	Yes
3	Lingual	More than 5 mm	Buccal and lingual	Yes
4	Buccal	Absent	Lingual	Yes
5	Buccal	Less than 5 mm	Lingual	Yes
6	Lingual	Less than 5 mm	Lingual	Yes
7	Buccal	Absent	Lingual	Yes
8	Lingual	More than 5 mm	Lingual	Yes

IAN, inferior alveolar nerve. 3ed M, third molar. MC, mandibular canal

Table 2: Patient's radiologic signs in CBCT scans images.

The buccal or lingual position of the IAN regarding the third molar or the associated lesion was evaluated according to Rubio and Mombrú classification system of deeply impacted third mandibular molars27. In addition, we considered if the nerve was in the same coronal position of the third molar or the associated lesion. Associated lesion size and boundaries were assessed and measured. If the lesion was large enough to jeopardize mandibular integrity and could lead to difficult bone reconstruction, another surgical technique was considered; and the patient was excluded from this study. Additionally, presence of bone between the mandibular canal and the dental roots or the associated lesion was easily identified in CBCT scan images.

All patients were treated under general anesthesia with nasotracheal intubation. The SSO was performed according to the Hunsuck-Epker 9,10 and Arnett techniques.12 Surgical approach was made by a mucosal incision first, and a muscular incision subsequently to allow a better closure of the wound. Afterwards, a mucoperiosteal flap was raised and the vertical osteotomy was performed at least 1.5 cm beyond the anterior boundary of the associated lesion to avoid a bad split and to allow bone contact between the fragments for a proper rigid fixation. The horizontal lingual osteotomy was not performed if the lesion involved the lingual cortex. The anterior ramus border osteotomy was performed as usual. After the osteotomies were made, two 2.0 plates with 4 monocortical screws each were placed and then retired, to complete the osteotomies and the fracture. Then, plates and screws were kept away in order, so they can be place later in the same position. Then, the split was performed as usual. The IAN was identified when possible, and the third molar, as well as the associated lesion were surgically removed. (Figure.3)

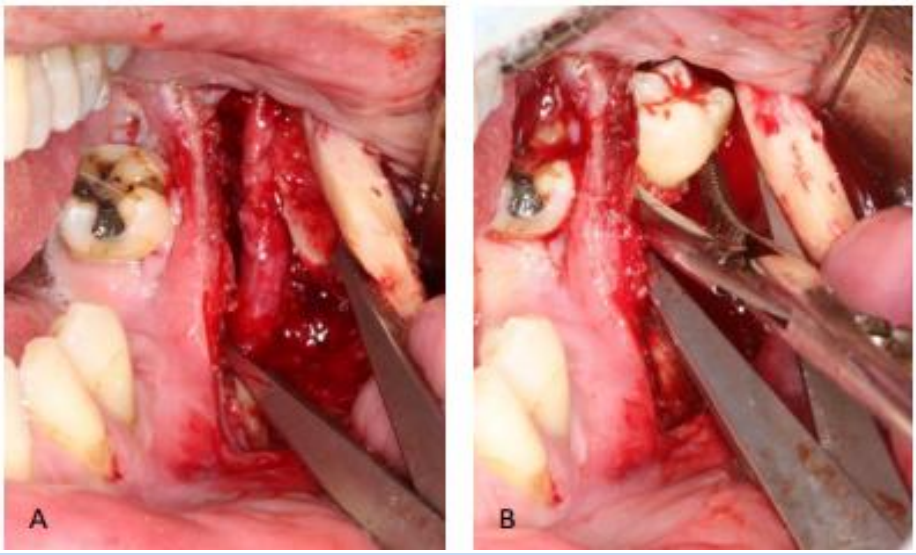

Figure 3: IAN identification and protection (A) during tooth extraction (B) by SSO technique in patient of figure 2.

The plates and screws were placed again in the original position (Fig. 4) and wound closure was performed with resorbable sutures.

Figure 4: Rigid fixation by two 2.0 miniplates and 4 monocortical screws.

No bone grafting materials were used, and no intermaxillary fixation was necessary in any patient. Perioperative and post operative antibiotics were administered. All patients were given parental antibiotics (amoxicillin 1 g) and corticosteroids in combination with nonsteroidal anti- inflammatory drugs intravenously for swelling and pain relief. The patients were discharged several hours after surgery, maintained with oral amoxicillin, nonsteroidal anti-inflammatory drugs for 5 more days and soft diet for at least 30 days. The sample and the outcomes variables were assessed by descriptive analysis only due to the small sample size. The outcomes were evaluated clinically at 7, 14, 30 days, 3, 6 and 12 months. Panoramic radiographs were taken at least 6 months after surgery. The outcome analysis was performed focusing on 1) the indication for removal of deeply impacted third mandibular molar by SSO 2) neurosensory disturbance (ND) after SSO 3) visualization and surgical access to the third molar and/or associated lesion with SSO 4) occurrence of a bad split 5) radiographic signs of bone healing 6) wound infection 7) damage to adjacent teeth and 8) postoperative changes of dental occlusion. The indication of SSO was analyzed according to the previous items. The ND was assessed according to Doucet JC et al 28 at 3 and 6 months after surgery. Patients who still had signs or symptoms of ND at 6 months were further evaluated again at 9 and 12 months after surgery.

Neuropathy of the IAN was defined as disabling when it interfered with daily activities.8 Surgical access and visibility with CBO and BCT were contemplated in all cases before surgery and evaluated with SSO during surgery, as well as an occurrence of bad split. Signs of bone healing and damage to adjacent teeth were assessed by panoramic radiograph at least 6 months after surgery. Finally, wound infection and changes of dental occlusion were evaluated clinically during all follow-up visits.

Results:

This study included 8 subjects (2 women and 6 men) with a mean age of 40.5 (range, 29 to 55 years). All patients underwent extraction of a deeply impacted third mandibular molar with SSO technique. Patient sample distribution according to indication for surgery, IAN position, thickness of the mandibular inferior border, histopathologic diagnosis, time of follow-up and complications are sown in table 1 and table 2.

At 3 months follow-up, all patients showed signs of some degree of ND. Between 6- and 12- months follow-up visit, 6 patients (75 %) showed signs of total neurosensory recovery with no other signs of complications, while In 2 patients (25 %) there was a non-disabling hypoesthesia of the IAN up to 12 months of follow-up.

The SSO provided adequate visualization of the tooth and pathology in all cases. However, IAN identification intraoperatively was not possible in all patients. No bad split, adjacent teeth damage or postoperative changes of dental occlusion were observed. Wound infection was occurred in one patient, treated uneventfully with removal of osteosynthesis material. No other complication was

observed. Panoramic radiographs showed signs of bone healing 6 months after surgery, without bone grafting materials. (Fig. 5)

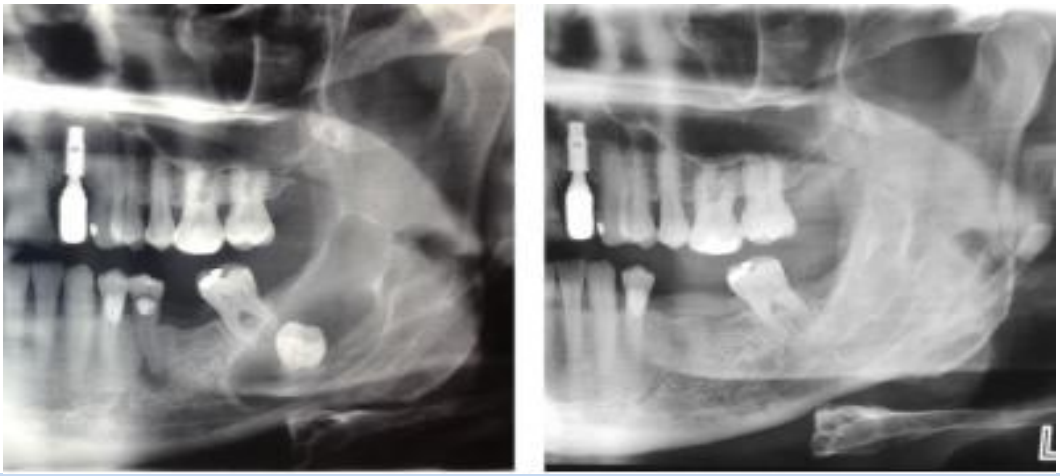

Figure 5: Radiologic signs of evident bone healing at 12 months after surgery.

Discussion

The purpose of this study was to evaluate indications, outcomes and complications associated with SSO for removal of deeply impacted 3 molars. In 1995, Amin et al.33 were the first authors to advocate the SSO approach for removal of an impacted lower third molar. in 2009, Sencimen1 et al emphasized the excellent and safe surgical access given by SSO for this purpose. In both studies, no occlusal and/or ND were reported. In 2017, in a case-series study by Catherine and Scollozi 2 18 patients were treated successfully with SSO for deeply impacted third molars extractions with low rate of complications.

The incidence of ND after SSO has been estimated by various subjective and objective measures, which vary considerably in their ability to detect and quantify any deficit. However, IAN injuries account for most of the postoperative complications of SSO 32. Age also has been linked to a higher risk of IAN involvement, which is less well tolerated in old versus young patients, and thus more often associated with incomplete recovery of the nerve function and permanent ND2. Generally, the incidence of ND after SSO has been reported as varying between 1.3% to 18%, most of which solved spontaneously 2,4,5,32. A limitation of CBO seems to be the impediment of IAN identification and protection with an increased risk of nerve damage, due to poor visibility. Most of the studies report that removal of mandibular third molars by use of the CBO, represents the most common cause of iatrogenic IAN injury.2,4,5 One of the main advantages offered by the SSO is that provides direct visual control of the IAN's relationships with the dental roots of deeply impacted teeth and mandibular associated lesions. Another option is BCT, which includes the temporary removal of the buccal plate to allow tooth extraction under direct visual control of the IAN. The bone flap is then repositioned and fixed with plates and screws. This approach is more straightforward than SSO, and it avoids the complications associated with this technique.

However, its disadvantages include the limited visualization of the IAN and the increased risk of IMF, in cases of lingual cortical plate excessive thinning 2,34 Nevertheless, if the mandibular canal is within the buccal cortex, it can lead to an injury of the IAN during SSO and BCT, if this anatomic variation is not studied on the CBCT scan images [2].

Although coronectomy could be an alternative, it is not indicated in cases with presence of infection and associated lesions. Moreover, the risk of root migration, may potentially require a second operation for their removal. [2]

Although, Pell and Gregory classification25 is still used worldwide, only provides information on third molar position in relation to the occlusal plane, cervical line of the second molar and about distance to the ramus. As CBCT scan images allow to assess IAN three-dimensional location, another classification system could be useful to offer more information in that concern. Any attempt of surgery by CBO could increase the risk of IAN damage when a buccal position of the nerve is confirmed by CBCT scan images. Therefore, if the nerve is in a lingual position, BCT should be considered as an alternative, but only if it is presumed that enough visualization will be feasible during surgery 2,4,5,34 IMF after the removal of impacted third molars have been reported to be more frequent by CBO owing to an excessive bone removal, in patients aged over 20 years.6 IMF associated with the removal of teeth, which can occur either immediately during the procedure or later, is considered rare with an under reported incidence ranging from 0.0034% to 0.0075%.

A possible reason for this, could be that most published information is presented in isolated cases reports or small series of cases 6, 30 According to Bodner et al. 30, in a review of 189 cases, the etiology of IMF for its occurrence are thought to be multifactorial. It included age, degree of tooth impaction, relative volume of the tooth in the jaw, preexisting infection or bony lesions, failure to maintain a soft diet in the early postoperative period, and the surgical technique. Age is an important risk factor for surgical complications after removal of third molars, essentially related to the increased incidence of ankylosed teeth, as well as sclerotic and brittle bone.2 A systematic review of 124 cases with IMF occurring in the postoperative period by Pires et al 6, showed that patients between the ages of 46 and 60 years were the most affected. No fractures occurred in patients aged under 20 years, and 68.6% of the fractures occurred in patients older than 36 years. Since almost 90% of third molar surgeries are done in patients younger than 35 years, it seems to be evident that the IMF increases with age.

Although some studies states that bone sclerosis with age increase risk of bad split with SSO, due to the loss of a clear bony cleavage plane between the cortex and the spongiosa, even when the osteotomy is properly completed 2, no bad split was recorded among

our 8 patients in this study.

Relative volume of the tooth in the jaw could be also an important risk factor concerning IMF. Wagner et al. 31 reported on 17 cases of IMF after CBO and found that the mean ratio tooth/ jawbone was 62%. However, this study used panoramic radiographs to assess the percentage area of the tooth within the bone for their calculations rather than CBCT scan images, which enables three-dimensional calculations of tooth volume within the bone. Additionally, in this study there was a strong association between the degree of dental impaction and age with IMF occurrence.

Additionally, extensive ostectomy with CBO is invariably necessary to remove deeply impacted teeth, being this another risk factor of IMF, due to consequent mandibular weakening.

The main advantage of SSO technique is that the amount of bone removal is limited only to the osteotomy's lines 2,6

patients included in this study had less than 5 mm of inferior border of the mandible thickness.

Two patients had direct contact between the tip of the third molar´s root and the inferior border of the mandible, hence absent bone.

This was considered as risk factor of IMF. Two patients had more than 5 mm of inferior mandible thickness, and in one of them both cortical plates were eroded by the associated lesion, increasing the risk of IMF by CBO.

The position of IAN in this sample was variable. Conversely, seven patients had the lingual cortical plate eroded, and one had both cortical plates eroded.

As a surgical pitfall, SSO seems to be especially useful in patients where the lesion lies entirely between the cortices. If the buccal bone is thin or eroded by the lesion, during splitting, the buccal cortical plate may disintegrate and lead to a bad split and thus, a difficult reconstruction of the mandible. CBO could be an alternative in those case, but only if it is presumed that enough surgical access and visualization will be feasible during surgery. The modification of making the horizonal cut buccally instead of lingually to maintain the bony continuity of the jaw, should be considered as well 15. However, according to this study, lingual cortical plate seems to be more frequently affected, as only in one patient buccal cortical plate was eroded by the associated lesion.

As SSO technique involve only bone removal limited to the osteotomy's lines, a "four walls" bone defect and sites of complete bone contact are possible, mainly if cortical plates were preserved. In 2015 Rubio and Mombrú 29 showed encouraging results in a randomized clinical study of 18 patient with cysts of the jaw treated by enucleation without bone grafting materials. In this study, bone regeneration was 100% in 12 patients, and higher than 50% in 6 patients, even in large lesions. Moreover, patients who showed more bone healing radiographic signs had integrity of bone cortical plates. Therefore, SSO technique could be helpful to achieve better bone healing at the defect site.

This study is a case-series with a small sample and without a control group, so no conclusions can be made about the utility of the described method as compared with other means of treatment such as CBO, OBC, coronectomy or observation.

In conclusion, SSO approach seems to be a safe method for removing deeply impacted third mandibular molars and associated lesions. SSO should be indicated mainly when the molar is located 5 mm or less over the basal bone, and when the IAN is in a buccal position or under the third mandibular molar´s roots. In cases of lingual position of IAN and/or eroded buccal cortical plate BCT or CBO should be considered as alternative techniques. Another indication should be for removal of third mandibular molars located in the ascending ramus, in which visualization and access is not enough. Is worth to mention that training in orthognathic surgery, should be necessary to diminish the possibility of bad split during the procedure.

Declaration Of Conflicting Interest

The authors declare that there is no conflict of interest.

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