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Coronectomy: A Case Series Demonstrating its Value in Younger Patients

Abstract: This article describes the value of coronectomy as an alternative to the removal of teeth in the management of younger patients when intervention is required but extraction is associated with a heightened risk of post-operative neuropathy. Three cases are presented of children who underwent a coronectomy procedure which was planned within a multidisciplinary Orthodontic, Oral Surgery and Paediatric Dentistry team at King's College Hospital. None of the children experienced post-operative neuropathy.
CPD/Clinical Relevance: This article describes the value of coronectomy (partial odontectomy) as an alternative to the removal of teeth in the management of younger patients when intervention is required but extraction is associated with a heightened risk of post-operative neuropathy.
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Coronectomy, or partial odontectomy, is a conservative surgical technique in which the crown of a tooth is removed but its roots/root are deliberately left *in situ*. In carefully selected cases, this alternative to the complete removal of a tooth may represent the treatment of choice in a number of clinical scenarios. It is most frequently used to reduce the risk of post-operative neuropathy in the management of symptomatic mandibular third molar teeth (M3M) which are considered, after the interpretation of available imaging, likely to be closely related to the inferior alveolar nerve (IAN).[1,2] There is a growing body of evidence that M3M coronectomy can reduce the incidence of post-operative disturbance in the function of the IAN when compared to extraction of these teeth when surgical intervention is unavoidable.[2-6]

The concept of coronectomy as a planned intervention is not new.[7] Its use in third molar surgery has, in recent years, received great attention from oral surgeons keen to improve the outcome for their patients presenting with symptomatic mandibular third molar teeth. Dysfunction of the IAN after third molar removal resulting in neuropathy (altered sensation, neuropathic pain or both) affecting the lower lip, chin, teeth or labial mucosa is uncommon but very distressing for many patients affected. In an increasingly litigious society, the desire to prevent unnecessary patient suffering and the medicolegal consequences of this has proved to be a potent driver of a change in clinical practice for many surgeons. Any dentist who has found him/herself in the position of being unable to complete a planned extraction and forced to leave the apical portion of a root *in situ* will recognize that this rarely results in any significant clinical complication. It is on a similar principle that the coronectomy of healthy, vital teeth as an elective procedure has been advocated.

The coronectomy of a non-third molar tooth may be indicated when symptoms or pathology associated with it dictate that it should be extracted but radiographs or cone beam computed tomography (CBCT) suggest that the surgical removal of the entire tooth would present an increased risk of post-operative neuropathy as a result of disruption to the IAN or its branches. This situation is seen most commonly in younger patients when there is a degree of failure in the eruption of mandibular premolar or molar teeth, causing them to be retained in an unerupted or partially erupted position. If the follicle of such a tooth communicates with the oral cavity, caries or symptoms of pericoronitis may result and necessitate surgical intervention. Alternatively, surgery may become necessary to prevent a malocclusion worsening, treat cystic change associated with an unerupted tooth or to address the effects of resorption on adjacent teeth from their unerupted counterparts. Case selection is, however, critical. This technique is not widely utilized for teeth other than third molars, although its application in the management infraoccluded mandibular

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first molars has been described.[8] Successful coronectomy relies on the retained roots remaining vital and there being healthy bony infill at the site previously occupied by the coronal portion of the tooth. Caries, apical pathology or pathological lesions, which cannot be completely excluded at the time of coronectomy, and tooth mobility are therefore contra-indications to this treatment.[9] Similarly, coronectomy should be avoided in patients with systemic conditions causing immunosuppression, which may impair healing and those who are being prepared for treatment with bisphosphonates, radio- or chemotherapy.

In their 2012 paper, Gleeson *et al*[10] elegantly described a six stage coronectomy technique for use on M3Ms. This approach translates well for use on other unerupted teeth; key features are summarized in Table 1.

In the hands of an experienced operator, the coronectomy of M3Ms has been shown to be a safe and effective procedure,[5,10] although evidence for similar success with other teeth is largely anecdotal. As for any surgical intervention, it is essential to recognize possible post-operative sequelae and complications and to discuss these pre-operatively with patients. The mobilization of the root fragments during the removal of the coronal portion of the tooth is the most frequently occurring intra-operative complication. This is more likely in single or short-rooted teeth and when the coronectomy cut is of inadequate depth or width, which requires the surgeon to apply greater force to fracture off the crown. If this problem is identified early, before the application of excessive force, the coronectomy cuts can be improved and procedure completed with the use of only minimal pressure. If this is not the case and the roots are mobilized during instrumentation, they must be removed using a technique least likely to result in nerve damage, which is often the result of mechanical compression rather than direct trauma.

In the early post-operative period, pain, alveolar osteitis and infection may complicate coronectomy, as they can the extraction of teeth. The regular use of simple analgesics usually suffices; infection and alveolitis should be managed as if an extraction had been performed. It is essential that acute, early post-operative symptoms are not incorrectly attributed to the presence of retained roots following coronectomy. These should be left *in situ* and the risks associated with their removal avoided until the indications for root removal can be assessed more accurately after the (expected) acute sequelae of surgery have resolved. Healing can be delayed or fail to progress after coronectomy, resulting in pain that persists beyond the early post-operative period. This can usually be attributed to the retention of mobilized roots or the presence of enamel on the retained tooth fragment. Root removal will usually be necessary in these situations.

The long-term complications associated with M3M coronectomy relate to the migration and eruption of the roots left *in situ*. A degree of movement in an occlusal direction is commonly seen on radiographs taken after coronectomy, although there is no indication to take radiographs specifically to monitor this. In the majority of cases, this migration is self-limiting and the roots remain entirely within the alveolar bone. Rarely, over a number of years, continued

	Technique	**Rationale**
Incision	■ Small, full thickness 3-sided flap ■ Preserve papilla mesial to M3M ■ Use of Minnesota retractor during procedure	■ Adequate access ■ Aids later primary closure ■ Prevents avoidable trauma to mucosa
Exposure	■ Use of fissure bur to expose CEJ ■ Remove bone to allow sectioning and removal of crown only ■ Refer to available imaging if IAN occupies a superficial buccal position	■ Exposes site of coronectomy ■ Vital tissue preserved ■ Avoidance of inadvertent damage to IAN
Decoronation	■ Partially section the tooth 1–2 mm below CEJ ■ Cut across 3/4 of the bucco-lingual width of tooth, along its full length ■ Remove crown by rotating a narrow Couplands elevator in deepest point of coronectomy cut ■ Use only minimal force, if resistance encountered consider adequacy of depth of cut	■ To reduce likelihood of retained enamel ■ To ensure that inadvertent breach of the lingual plate and soft tissues does not result in lingual nerve injury ■ This propagates a fracture through the remaining lingual enamel wall ■ The application of greater pressure increases the risk of mobilizing root fragments and nerve injury
Finishing of the surface of the root	■ Use round bur to reduce the cut surface of the root face to 2–3 mm below the alveolar crest ■ Remove any remaining enamel ■ Remove remnants of coronal pulp	■ Encourages bony deposition ■ This inhibits bony healing ■ This may reduce post-operative discomfort
Debridement of socket	■ Irrigate with saline ■ Ensure all debris removed ■ Final check to ensure complete removal of enamel and depth of retained roots	■ Allows careful inspection of socket ■ Optimizes healing ■ Optimizes healing
Closure	■ Tension-free, primary closure should be achieved using interrupted sutures	■ Promotion of healing and minimization of post-operative discomfort

Table 1. Key features of a six-stage coronectomy technique for use on M3Ms.

movement may result in the roots erupting into the oral cavity. This can cause soft tissue inflammation, localized infection and pain. As root fragments migrate towards the oral cavity they move away from the IAN they were previously closely related to so, if their removal is indicated, this is usually an uncomplicated procedure.[11]

The role of Cone Beam Computed Tomography (CBCT) in coronectomy

The risk of damaging an adjacent vital structure, such as a neurovascular bundle, during the extraction of teeth is recognized by all dentists. Those practitioners who undertake surgery at sites where this is predictably problematic will be familiar with the radiographic signs that are predictive of increased risk of IAN injury during third molar removal. These have been evaluated[12] and loss of continuity of the radio-opaque lines corresponding to the cortication of the inferior dental canal (IDC) and diversion of this canal have been identified as predictors of heightened risk due to close nerve-root contact. These radiographic signs can also be observed, less frequently, in relation to the roots of erupted or unerupted mandibular molars or premolars and must be interpreted appropriately by those responsible for the treatment planning of younger patients in order to avoid preventable post-extraction neuropathy.

When plain radiographs are suggestive of an increased risk of a close relationship between the roots of a tooth and the IDC, the attending clinicians should consider the indication for CBCT. This will allow the anatomical relationship between these two structures to be examined in detail in three dimensions, providing an appreciation of the feasibility of tooth removal without nerve injury. When 'intimate' tooth-nerve contact is suggested by the appearance of the loss of cortication or a change in the morphology of the IDC on CBCT, the case for coronectomy of a healthy tooth becomes stronger. Where associated pathology precludes this, the additional information obtained from the scan allows the surgeon to plan and modify their surgery to render iatrogenic damage to the nerve as unlikely as possible. CBCT also provides valuable information about the relationship of an unerupted tooth to its neighbours and allows the extent of resorption, if any, to be accurately assessed.

In keeping with best practice, IR(ME)R and European Commission radiation protection guidance, the use of CBCT in children should be restricted to complex cases in which the benefit of additional diagnostic information obtained outweighs the additional radiation risk. The dose received by the patient should be further minimized by scanning the smallest possible volume size.[13]

We present three cases of patients treated at King's College Hospital to demonstrate the use of coronectomy in the developing dentition. These patients had CBCT scanning as part of their multidisciplinary assessment in a 3DX Accutomo scanner (J Morita Corporation, Tokyo, Japan).

Case 1

A 10-year-old girl was referred from a specialist orthodontic practice regarding her unerupted LL6. The patient presented with a Class I incisal relationship on a Class II skeletal base complicated by an unerupted LL6, increased overjet of 5.5 mm, and a 2 mm shift to the left of the mandibular centre-line. On examination, the LL7 appeared to be partially erupted whilst the LL6 was neither visible nor palpable. There was no buccal or lingual expansion of the alveolus in this region.

A dental panoramic tomograph (DPT) was provided by the referring orthodontist (Figure 1). This showed that the LL6 was unerupted and unfavourably positioned with its apices at the lower border of the mandible. A well-defined radiolucency associated with the cemento-enamel junction of this tooth was suggestive of a dentigerous cyst which appeared to communicate with the oral cavity distally. A CBCT of the left mandibular molar region was obtained to clarify the anatomy of the LL6 and to assess its relationship to the IDC. The scan revealed that this tooth had four rootlets which appeared to have developed as a result of the deflection of the developing mesial and distal roots around the cortical margins of the mandibular canal. The apices of all four rootlets were noted to be lying within the cortical plate at the lower border of the mandible and appeared to demonstrate significant curvature (Figure 2). The IDC was seen to be intimately related to the tooth, running between the two buccal and two lingual rootlets (Figure 3). From the imaging available it was appreciated that the complete surgical removal of the unerupted LL6 would be technically challenging because of its anatomy and associated with heightened risk of IAN injury due to the relationship between the roots of the tooth and the nerve.

After comprehensive discussion with the patient and her parents it was agreed that, in order to facilitate the orthodontic treatment she was keen to have, and to prevent acute symptoms arising from the LL6, a coronectomy of this tooth would be undertaken. They were fully aware that some residual spacing in the left molar region was to be expected on completion of orthodontic treatment due to the presence of the retained roots of the LL6. The family were prepared to accept this in order to avoid the risk of

Figure 1. Pre-operative DPT provided by the referring orthodontist.

Figure 2. Parasagittal view of the CBCT of the LL6 showing curved, divergent roots within the cortical plate of the lower border of the mandible.

neuropathy which could have complicated the complete removal of this tooth. It was agreed with the consultant orthodontist involved in the patient's care that the coronectomy would be performed at a low level to minimize the interference with the orthodontic alignment of the adjacent teeth.

Coronectomy of the LL6 was performed under general anaesthetic (Figures 4 and 5) and primary closure was achieved. The soft tissue associated with the crown of the tooth was curetted and sent for histopathological analysis. The specimen was reported to be an enlarged fibrous dental follicle.

At review two weeks after surgery, the patient reported no pain or altered sensation in the distribution of her left IAN and soft tissue healing at the coronectomy site was noted to be progressing well. A sectional DPT taken at this time confirmed the complete removal of the crown of the tooth LL6 (Figure 6).

Orthodontic treatment included the use of head gear and removable and fixed appliances to distalize the molar teeth, reduce the overbite and align the remaining teeth. This treatment was started 18 months after coronectomy following the full eruption of the second molars and took 30 months to complete. The DPT and photographs taken just prior to de-bond (Figure 7) demonstrate an excellent result in closing the space overlying the retained roots of LL6, albeit accepting a Class II buccal relationship on the left-hand side.

Case 2

A 6-year-old boy was referred by his dentist regarding his missing LRE. There was no history of pain or swelling. Clinical examination confirmed that this primary molar was absent; otherwise the dentition was developing as expected, although the eruption of the LR6 was less advanced than that on the left.

Radiographic assessment showed the LRE to be present with its apices at the lower border of the mandible. The mesial and distal roots appeared divergent. A well-defined unilocular radiolucency was noted to be associated with the crown of the tooth and there was a suggestion of some small radio-opacities within this. The LR5 was not seen (Figure 8).

A CBCT was carried out utilizing a small (4 x 4 cm) field of view to examine the anatomy of the unerupted primary molar and its relationship to the IDC. This scan confirmed the inferior position of the tooth within the mandible and that the LR5 was absent. The unerupted primary molar was identified as having two mesial and one distal root which split into two apices, so there were four apices in all. The roots and the apices were flattened, curved and divergent (Figure 9). The IDC was observed to run lingual to the roots of the unerupted tooth, compressed against the lingual plate (Figure 10). The crown of the unerupted primary molar was seen to be surrounded by an enlarged follicle which contained several small, round opacities with a radiodensity similar to that of enamel. The margins of this lesion were noted to be well defined and corticated; differential diagnoses included: dentigerous cyst, adenomatoid odontogenic tumour and ameloblastic fibro-odontoma.

After a six month period of monitoring, the clinical and radiographic pictures remained unchanged, however, it was felt that the lesion overlying the unerupted tooth should be removed in order to establish its nature, prevent acute symptoms arising as a result of the development of a communication with the oral cavity, and to minimize the adverse effect on the rest of the developing dentition. The complete removal of the lesion was believed to necessitate the removal of at least the crown of the tooth. The treatment options discussed with the child's parents included; continued monitoring with no active treatment, surgical removal of the LRE and coronectomy of this tooth. Given the technical challenge of attempting to remove the whole tooth and the risk of nerve injury associated with this, the decision was made to proceed with coronectomy. The family were warned of the risk of damage to the IAN and that a second procedure may be required to retrieve the roots if healing was incomplete or symptoms persisted.

The coronectomy of the LRE was carried out under general anaesthetic. The associated soft tissue lesion and mineralized material (which resembled small denticles) within it were removed completely and sent for histopathological analysis. The histopathological appearance of the specimen was essentially that of a microscopic odontome within disorganized odontogenic tissue and not entirely consistent with any of the defined odontogenic tumour entities, so a diagnosis of a follicular hamartoma was suggested. At post-operative review the patient reported no altered sensation or pain and the soft tissues in the region of the coronectomy had healed well. A radiograph taken one year after surgery demonstrated good bony infill and that the roots of the coronected primary molar had not migrated (Figure 11). Intriguingly, the radiograph also appeared to show a tooth-like structure developing superior to the retained roots. Time (and

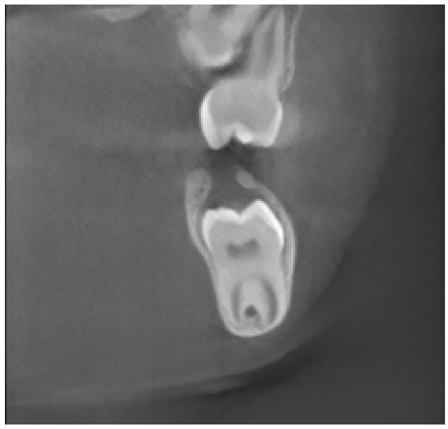

Figure 3. Coronal section of CBCT of the LL6 demonstrating an intimate relationship with the IDC which runs between its buccal and lingual roots.

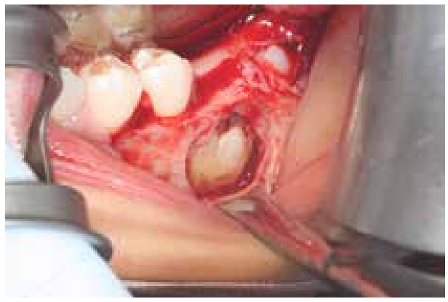

Figure 4. An intra-operative view of the surgical exposure of the LL6.

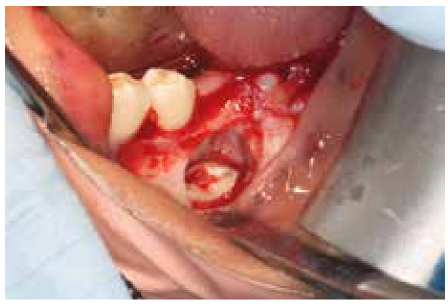

Figure 5. An intra-operative view of the LL6 following coronectomy.

Figure 6. Sectional DPT showing the roots of the LL6 *in situ* after coronectomy.

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b
c

continued monitoring) will tell whether this will take the form of a premolar of normal morphology or a simpler supernumerary tooth but, given the extent of the bony defect at the time of coronectomy, this was an unexpected development!

Case 3

A 15-year-old girl was referred by her dentist regarding the presence of multiple supernumerary ($) and impacted teeth. She was known to suffer from neurofibromatosis type II.

On examination the LRE, LRD and LLE were noted to be retained whilst the LR4, LR5, LL4, LL5 and the UR5 were absent. A DPT (Figure 12) demonstrated the presence of one supernumerary tooth in the premolar region of both maxillary quadrants and two supernumerary teeth in the premolar region of each mandibular quadrant. The UR5 and all four mandibular premolar teeth were seen to be unerupted and impacted. A CBCT was obtained to assess the position, orientation and relationship of the unerupted teeth to

d
f
e

Figure 7. Intra-oral views of the final orthodontic result achieved and a DPT taken prior to de-bond demonstrating complete space closure in the left mandibular quadrant following fixed appliance treatment. **(a)** Right lateral intra-oral view of the teeth in occlusion. **(b)** Front intra-oral view of the teeth in occlusion. **(c)** Left lateral intra-oral view of the teeth in occlusion. **(d)** Occlusal intra-oral view of the mandibular teeth. **(e)** DPT taken prior to de-bond demonstrating space closure over the retained roots of the LL6. **(f)** Occlusal intra-oral view of the maxillary teeth.

Figure 8. DPT showing the unerupted LRE and associated radiolucency.

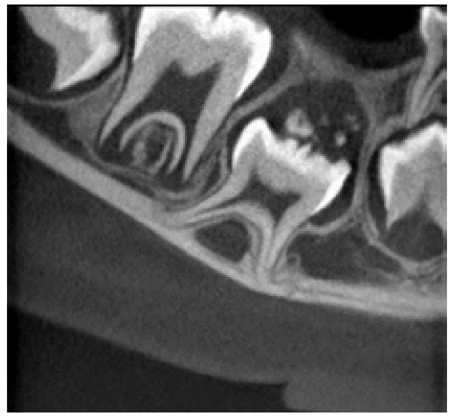

Figure 9. Parasagittal view of the CBCT of the impacted LRE with associated radiolucency containing radio-opaque material.

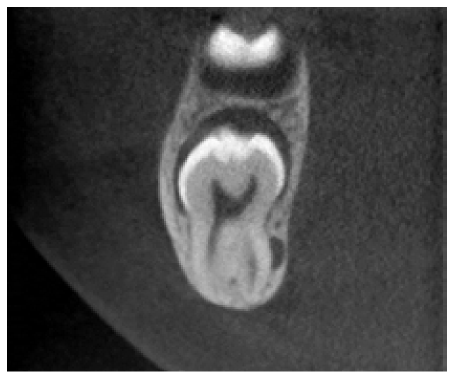

Figure 10. Coronal view of the CBCT demonstrating the intimate relationship between the root of the LRE and the IDC on its lingual aspect.

Figure 11. Sectional DPT showing the position of the roots of the LRE after coronectomy.

adjacent structures and to ascertain whether the teeth adjacent to the supernumeraries had been resorbed. The scan revealed that the UR$ had caused only minimal resorption of the distal aspect of the UR4, but that it had prevented the eruption of the UR5 which had a curved root and had itself caused a degree of resorption of the UR6 roots (Figure 13). The UL$ was noted to have caused a degree of resorption of the UL4 (Figure 14). In the mandibular arch the supernumerary teeth were seen to lie inferior to the primary molar teeth bilaterally. The LRE was noted to have two divergent roots between which the incisive branch of the IDC passed. Bilaterally, the crowns of the LR5 and LL5 were closely associated with the mesial roots of the first molars and a degree of resorption was suspected (Figure 15). The IDC was seen to run on the buccal aspect of the impacted LR5 and LL5 before reaching the mental foramina (Figure 16).

Extraction of the supernumerary and retained primary teeth in addition to the UR5 was carried out under general anaesthetic. Post-operative recovery and healing was uncomplicated. At review a year later the maxillary arch appeared well aligned and the position of the LR4 and LL4 had improved markedly, although these teeth remained unerupted. The position of the LR5 and LL5 appeared more unfavourable than before (Figure 17).

A further CBCT scan confirmed that the LR5 and LL5 had moved in a disto-angular direction and had caused resorption of the mesial roots of the LR6 and LL6, respectively. The IDCs were again noted to run in contact with the buccal aspect of the roots of the second premolars.

Although continued monitoring of the mandibular arch was an attractive option to avoid further surgery and the risk of bilateral nerve injury in this young patient, intervention was necessary to prevent further resorption and possible loss of the mandibular first molars. Given the intimate relationship observed between the LR5 and LL5 and the canals of both the mental and inferior alveolar nerves on CBCT, coronectomy of both teeth was considered the most appropriate treatment modality and this was subsequently carried out under general anaesthetic. At review six months later the patient reported neither transient nor persistent neuropathy. A DPT confirmed that there were no radiographic signs of pathology associated with the retained roots (Figure 18).

Discussion

The three cases presented demonstrate how coronectomy can be used as an effective alternative to the removal of teeth in situations where extraction would be associated with an unacceptably high risk of post-operative neuropathy. The possibility of this rare but highly undesirable and disabling outcome should be avoided in the treatment planning of all patients but does, however, seem particularly important when considering the management of young patients who often present with an asymptomatic dentition.

It is important to appreciate that, although coronectomy is a useful technique, it can be complicated by post-operative neuropathy or the iatrogenic damage of adjacent teeth. There is also a small risk that, either intra- or post-operatively, this procedure will fail and the retrieval of the roots with attendant risks will be unavoidable. It should therefore be considered a risk reducing but not risk free procedure and the pre-operative counselling of patients and their carers regarding this is essential. Chalmers *et al*[8] suggested that, following a coronectomy, the presence of the retained roots would necessitate the acceptance of residual spacing in the overlying dental arch at the completion of orthodontic treatment. Our experience is that close liaison with orthodontic colleagues from the time of initial treatment planning allows the outcome of any appliance therapy to be optimized. Discussion regarding the level at which the coronectomy should be performed allows the surgeon to understand what he/she can do to minimize the disturbance to the alignment of the dentition attributable to the deliberate retention of roots.

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Figure 12. Pre-operative DPT demonstrating multiple supernumerary and impacted teeth.

Figure 13. Parasagittal view of the CBCT of the right maxilla demonstrating the presence of a supernumerary tooth which has prevented the eruption of the UR5.

Figure 14. Parasagittal view of the CBCT of the left maxilla demonstrating resorption of the UR4 root by the adjacent supernumerary tooth.

Figure 15. Coronal view of the CBCT demonstrating the relationship between the impacted LR5 and LL5 with the IDCs apically and the mental canals buccally.

Figure 16. An axial view of the CBCT of the anterior mandible showing the relationship of the IDCs to the LR5 and LL5.

Figure 17. DPT taken one year after the removal of supernumerary teeth and UR5.

Figure 18. DPT showing the retained roots of the LR5 and LL5 after coronectomy.

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