A surgical procedure to eliminate rotational relapse

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Many orthodontists evaluate the retention phase of orthodontic treatment as the most difficult problem of therapy. In fact, the more conscientious the orthodontist, the more he might regard retention as *the* problem in treatment. Angle[1] summarized orthodontic retention as follows: "After malposed teeth have been moved into the desired position they must be mechanically supported until all the tissues involved in their support and maintenance in their new positions shall have become thoroughly modified, both in structure and in function, to meet the new requirements.'' As every clinical orthodontist realizes, however, it is far easier to summarize the ideals of a successful retention program than to accomplish them during actual treatment.

The type and duration of the varying retentive measures are clinically determined by a myriad of factors—the number of teeth moved, the extent of orthodontic movement, the previous occlusion and age of the patient, the alleged cause of the particular malocclusion, habits related to the mouth, the actual cuspal anatomy of the teeth involved, the health of the periodontium, muscular pressures in the oral region, problems of apical base limitations, facial growth changes, and perhaps even atmospheric pressure.[5, 13, 14, 22] In any event, very few practitioners underrate the significance of retention in successful orthodontic therapy.

Additional knowledge of facial growth and development, greatly improved techniques of orthodontic mechanics, and recent advances in diagnosis of the various factors related to dentofacial deformities have all enabled the orthodontist to obtain better treatment results—results which would seem less likely to cause problems in the retention phases of treatment. Nevertheless, relapse tendencies still exist in a fairly high percentage of treated malocclusions, especially in the cases studied over a period of years following active correction. Volumes have been written on the causes and prevention of retention failures, but to date there still exists great validity to Hellman's[17] complaint: "We are in almost complete ignorance of the specific factors causing relapses and failure."

Although an orthodontist today has the capabilities to achieve dramatic results in altering entire jaw relationships with the use of adapted orthopedic principles, the field of operation in the more routine orthodontic case is restricted primarily to the relatively small area of the supporting structures of the teeth themselves. The retention of the individual dental movements (as opposed to movements involving entire alveolar segments of teeth or the actual bony bases) still demands continued investigation. An earlier study that I made was concerned principally with the physiology and related anatomy of orthodontic rotation of teeth.[7] While these earlier investigations were undertaken with a less direct interest in developing an improvement in tooth movement or retention than in furthering a better understanding of the dental periodontium as it relates to orthodontic therapy, it was hoped that an eventual clinical application would be forthcoming from that research.

The present investigation has attempted to develop and study the efficacy of a simple surgical technique to lessen the problems that arise during retention of orthodontically rotated teeth.

Review of the problem

It is now generally recognized that retention must be appreciated as one aspect of the over-all orthodontic treatment; relapse of orthodontically treated teeth should be viewed not as a pathologic or abnormal phenomenon but as an unwanted or undesirable symptom of normal oral physiology. Thus, a pragmatic search for an implement to alleviate the relapse of orthodontically treated teeth in general and orthodontically rotated teeth in particular must be developed on the basis of a comprehensive understanding of the supporting tissues of the teeth.

A rather thorough review of the physiology and anatomy of tooth rotation and retention has been compiled in an earlier report.[7] The plastic osseous tissues of the periodontium appear to have little difficulty adapting to the new position of a rotated tooth, but the exact mechanism by which fibers in the periodontal ligament permit extensive orthodontic rotations of teeth is not clear. It is, indeed, a temptation to explain rotational movement by referring to the existence of an "intermediate plexus" in which could occur the dissolution of fiber connections, the production of new fibers, and the formation of new functionally adapted fiber connections.[27, 28, 30] However, this intermediate plexus, described by Sicher[29] as possessing a great number of fibroblasts undergoing mitotic division, is not routinely observed in either erupting teeth of mice or orthodontically rotating teeth of dogs.[6, 7, 35, 37]

It is obvious that the length of individual fibers is not sufficient to span the distance from cementum to bone. This situation is resolved by the fact that many fibers cooperate in the lengthening of a collagen bundle. It must be realized also that groups of fibers might divorce themselves from a parent bundle and combine with another neighboring fiber bundle. It can be argued that orthodontic forces (as well as forces causing natural tooth eruption) stimulate fiber groups to disassociate themselves from established bundles, to unite with other fiber groups, and thus to accomplish the altered position of the rotated tooth. Such a theory of "slippage" (reorientation of existing collagen fibers) was postulated by Orban and associates.[20]

In summary, the majority of more recent investigations would indicate that the fibrous elements of the periodontal ligament adapt to tooth movement in possibly three ways: (1) Progressive osteogenic activity (and cementogenic activity, to a far lesser degree) plays an active role in the shortening of the extended fibers and in the reattachment of new fibers developed during the tooth movement; (2) the stretching of the wavy collagen fibers and reorientation of their directional morphology permits a certain amount of tooth movement; (3) the existence of a type of intermediate plexus might allow an elongation of fiber bundles by "slippage" of the fibers over one another and a subsequent reorientation of the fibers in the new position.

Thus, the final return of the slow-metabolizing[19] connective tissue fibers to their original and stable relationship to the rotated tooth and to each other depends to a great extent on the remolding of the osseous tissue. It is also apparent that such reorganization of the periodontal ligament and adjacent alveolar bone is a relatively rapid process. The supracrestal (gingival and transseptal) fibers, of course, do not have the plastic osseous tissue to eliminate their distortions after tooth movement. These observations, therefore, have provoked a great deal of interest in the role which the gingival fibers might play in relapse of orthodontically rotated teeth.

Reitan[23, 25] was one of the first to report that the collagenous supporting fibers of the gingiva appear histologically taut and directionally deviated after tooth rotation. This fiber alteration does not appear to lessen in the supracrestal tissues after even long periods of retention.[7, 25] By means of a simple tattooing technique, it has previously been shown that the attached gingiva, especially the marginal gingiva, is indeed pulled along with the tooth as it is rotated.[7] Thus, the fibers of the gingiva do remain attached to the tooth during orthodontic rotation, which results in a displacement of the gingiva in the direction of tooth movement.

Nevertheless, it has not been conclusively shown that during orthodontic rotation an elastic force is generated in the fibrous attachments which would tend to rerotate the tooth, especially since there are reputedly no fibers of the elastic type in the human periodontium.[13, 27, 29] In recent months, however, at least two studies have observed an increase in definition and quantity of oxytalan fibers (a fiber thought to be related to elastic tissue) during orthodontic tooth movement.[2, 7] Such reports of these "elastic" oxytalan fibers in the periodontium of rotating teeth might suggest possible anatomic explanations for the relapse tendency of orthodontically rotated teeth.

In any case, while the exact reason for relapse of orthodontically rotated teeth has not been fully defined, a number of clinical measures have been adapted to prevent such relapses.[13, 21, 22] Perhaps some of the most popular philosophies for retention of rotated teeth are the following: (1) rotations must be corrected by overrotation in the opposite direction; (2) rotated teeth must be retained over an especially long period of time, preferably with a fixed retainer; (3) treatment of rotated teeth must be performed at an early age; (4) any rotational technique which produces sufficient amounts of osteoid tissue in the root area will aid in retention of the rotated tooth; (5) a properly equilibrated occlusion will practically eliminate retention worries.

While it is true that osteoid tissue will not resorb as readily as mature bone, it has now been shown that any retentive effect of an osteoid layer surrounding a rotated tooth is effective for a matter of only a few days, as osteoid is rapidly transformed into new bundle bone—a type of bone more resorbable than mature cancellous bone.[26] Thus, since osteoid tissue cannot be relied upon to hold a rotated tooth in position, some type of mechanical retention must be used in every case. Moreover, despite the hope that a properly equilibrated articulation of opposing teeth will alleviate rotational relapse, too frequently clinical observations seem to indicate that occlusion is a secondary factor in determining relapse patterns.[2]

Reitan,[24] among others, has advocated the use of early rotation to lessen relapse. He feels that such early treatment will ensure stability, since there will be formation of new and stronger ligamentous fibers as the apical portion of the root completes its growth after the tooth has already been rotated to its proper position. Such a postulation is surprising, since Reitan himself was the first to report that alterations in the fibers and bone attached to the root of the tooth rapidly reorganize and adapt to the new positions of a rotated tooth.[23, 25] Apparently there exists little evidence that the periodontal ligament and its alveolar tissue play any significant part in rotation relapse after 2 to 3 months of mechanical retention.

Indeed, recent studies have demonstrated that even the value of overrotation and prolonged retention in previously rotated teeth to achieve a significant increase in stability appears questionable.[2, 24, 25] Nevertheless, the more thorough clinical and histologic investigations seem to indicate that the existence of a major relapse "pull" on a rotated tooth appears to be located somehow in the supracrestal fibers.[2, 7, 13, 24, 25, 32]

In an attempt to alleviate the unexplained but disturbing problems of relapse after correction of rotational positions of teeth, orthodontic clinicians have also developed an array of surgical methods to aid in the retention process. Some have believed that chances for relapse are greatly reduced if the malaligned tooth is rotated forcibly with surgical forceps.[15] Evidently, this "immediate torsion" treatment is intended to destroy completely all fibrous attachment to

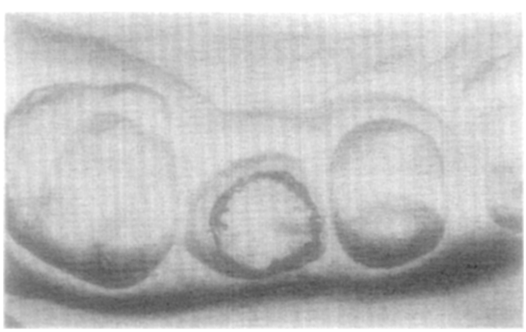

Fig. 1. Rotated tooth before correction.

the tooth and allow new attachment after rotation. Unfortunately, this method does not appear to lessen relapse significantly and has been proved to result in frequent pulpal degeneration.[16]

Skogsborg[31] devised the rather radical surgical technique of septotomy to lessen frequency of relapse in rotated teeth. This method, which employs vertical sections through the entire alveolar process mesial and distal to the rotated tooth from a level parallel with the apex of the root to the alveolar crest, is too poorly documented for credibility. Kole[18] would remove the buccal and lingual cortical plates before orthodontic movements in an effort to eliminate the relapse phenomenon. Brauer[4] and Tsopel[34] found that transsecting the supracrestal fibers with vertical incisions mesial and distal to the rotated tooth may reduce the danger of relapse. Thompson[32] and Boese[2] removed all of the attached gingiva (leaving only the mucosa) surrounding the rotated teeth in experimental animals and reported a significant reduction in relapse after an initial retention of 4 to 8 weeks.

Statement of the problem

Many theories and clinical methods have been developed by orthodontists for alleviating the problems of relapse following the rotation of teeth. At the present time no clinical technique has been shown to reduce rotational relapse significantly and predictably. There are a few reports in which radical gingivectomy seemed to lessen the relapse tendency, but such removal of attached gingiva in the human patient is certainly not practical.

The purpose of the present investigation is to study a selective surgical technique which is intended to reduce relapse of rotated teeth significantly but not to damage the periodontium. A simple tattoo technique, developed in a previous study[7] to show a correlation between microscopic and macroscopic

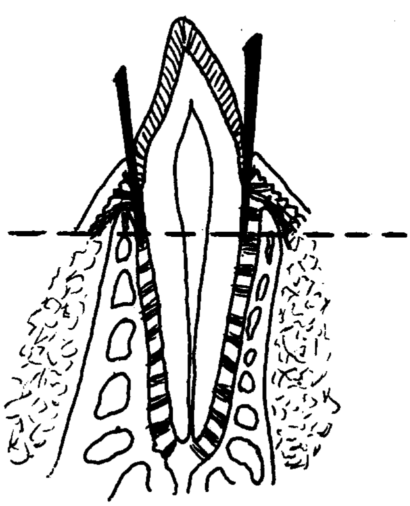

Fig. 2. Level approximately 2 to 3 mm. below alveolar crest to which incision is extended.

reports of gingival tissue alterations during orthodontic rotation of teeth, has been used in the present study to evaluate the surgical procedure in releasing the "pull" which periodontal fibers presumably have on the rotated tooth.

Methods and materials

Twelve teen-aged orthodontic patients (between the ages of 13 and 16 years) consented to participate in this clinical investigation. All twelve patients presented at least one malrotated tooth, and there was a total of sixteen experimental teeth. Both anterior and posterior teeth were available for the orthodontic rotation program. Fixed orthodontic appliances were employed to rotate the study teeth as part of the patients' total orthodontic therapy. Elastic thread provided the force system for the rotation of all experimental teeth. The extent of malrotation of the experimental teeth varied from 20 to 90 degrees. Rotational movement was completed as rapidly as the patients' pain thresholds permitted (approximately 20 degrees per 4-week period).

Fig. 3

Fig. 4

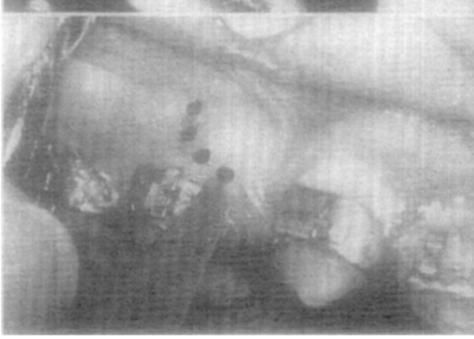

Fig. 5

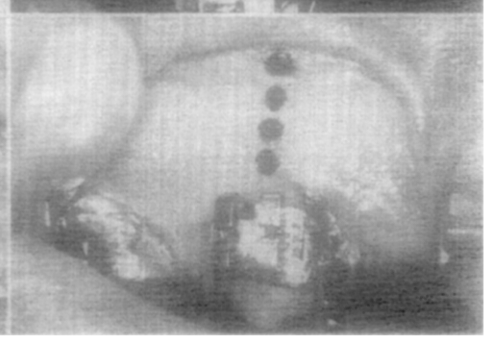

Fig. 6

Fig. 3. Tooth following orthodontic rotation.

Fig. 4. Deviated tattoo line on gingiva following rotation of tooth.

Fig. 5. No. 11 Bard-Parker blade entering gingival sulcus to sever supracrestal fibrous attachment around circumference of tooth.

Fig. 6. Periodontal probe showing normal sulcular depth one week after surgical procedure. Note that tattoo marks have reverted to original vertical alignment.

Fig. 7

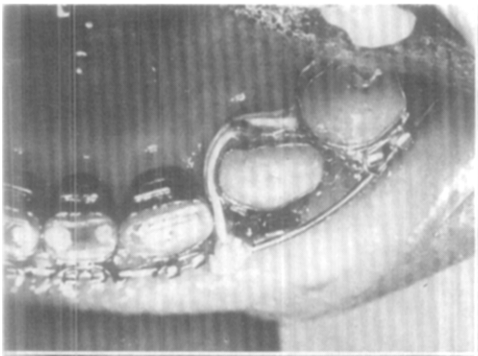

Fig. 8

Fig. 9

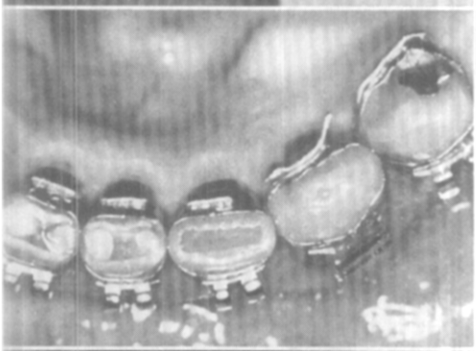

Fig. 10

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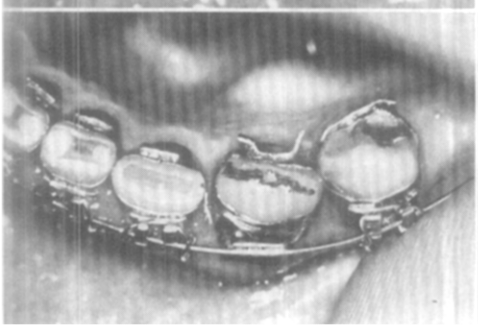

Fig. 12

Fig. 7. Malaligned canine tooth under rotational forces.

Fig. 8. Vertical tattoo line on gingiva before rotational correction.

Fig. 9. Incisal view of canine tooth after rotational correction.

Fig. 10. Deviated tattoo markings in direction of tooth rotation. Note accumulation of gingival tissue distal to rotated tooth.

Fig. 11. Canine has relapsed approximately 20 degrees in 2 months following full rotational correction.

Fig. 12. Tattoo marking has also "relapsed" toward vertical arrangement as tooth relapsed.

Prior to any active orthodontic rotation, vertical line markings were tattooed on the attached gingiva and mucosa surrounding the experimental teeth. Commercial India ink, autoclaved at 265° F. for 60 minutes and then injected into the gingival tissue with a 29-gauge disposable needle and syringe, was employed in the tattooing procedure. No anesthetic was necessary. Photographs of these markings were taken at varying intervals during the phases of active tooth rotation and retention.

In eight of the experimental teeth all restraining arch wires were removed for a 3-month period after the rotational movement had been completed and the teeth had been retained for 2 months. Any rotational relapses, as well as alterations in the gingival tattoo markings, were recorded. These same teeth were then rerotated to correct alignment. No attempts were made to overrotate any of the sixteen study teeth.

Upon completion of rotational movement and 8 weeks of mechanical reten-

Fig. 13

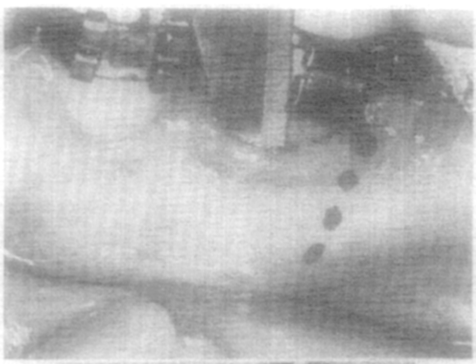

Fig. 14

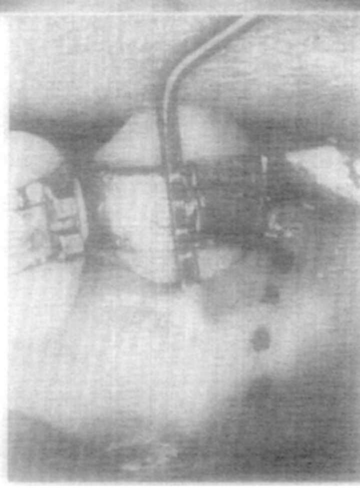

Fig. 13. Surgical blade severing fibrous attachments around tooth to a depth below alveolar crest; surgical procedure followed correction of rotational relapse.

Fig. 14. Periodontal probe showing 6 mm. sulcular extension following surgical procedure. Note that tattoo markings are still deviated.

tion, all experimental teeth were subjected to a periodontal surgical procedure in an attempt to alleviate the relapse tendency of the rotated teeth. This surgical technique consisted of inserting the point of a No. 11 Bard-Parker blade into the depth of the gingival sulcus and severing all fibrous attachments surrounding the tooth to a depth approximately 3 mm. below the crest of the alveolar bone. Local infiltration of Xylocaine provided the anesthesia. No excision of attached or marginal gingiva was undertaken in these procedures. Following the surgical procedure, a dressing (Squibb's Orahesive) was placed for 5 to 8 days. A periodontal probe was used to ascertain the sulcular depth before and after the procedure, as well as after healing. Photographs were made of the tattoo markings during the surgical procedure and after dressing removal. The degree of rotational relapse was again recorded after a 3-month period following the surgical procedures; no mechanical retention was used during this final observation period following surgical intervention.

Observations

It was observed that in each instance the amount of deviation between the originally vertical line of tattoo marks coincided consistently with the amount

Fig. 15

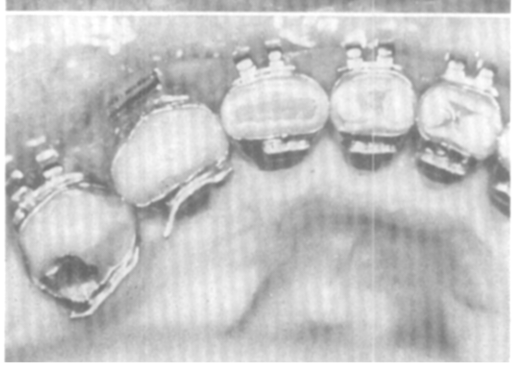

Fig. 16

Fig. 15. Probe showing normal sulcular depth 10 days after surgical procedure. Tattoo marks are now in original vertical alignment.

Fig. 16. Incisal view showing no rotational relapse 3 months following surgical procedure. No mechanical retention was employed postoperatively.

of rotational movement of the tooth. The attached gingiva and, to some extent, the mucosa, apparently did follow in the direction of rotation. It was often observed that in cases of large rotational movement, gingival tissue appeared to accumulate (in a "piled-up" fashion) in the interdental area toward which the tooth was rotating.

After all experimental teeth were rotated to proper alignment, they were retained with a fixed arch wire for 2 months. After this retention period, eight of the previously rotated teeth were allowed to relapse by removing the arch wires. All teeth did rerotate to some degree, and the tattoo lines again showed tendencies to revert to their original vertical positions. Interestingly, there appeared to be little correlation between amount of relapse and amount of orthodontic rotation.

During the previously described surgical procedures, the deviated tattoo markings were not seen to revert immediately to a vertical configuration. Within 20 to 40 hours, however, all tattoo marks, with one exception, were observed to be again in a vertical line parallel to the long axis of the tooth. The tooth whose tattoo markings failed to alter after the surgical procedure was subjected to additional surgical intervention with special emphasis on deepening the incision below the marginal crest. Within 28 hours after the second surgical procedure, the tatto markings were also observed to have become vertically aligned. Thus, the initial failure of the gingival markings to realign themselves was apparently due to insufficient attention in severing the fibrous attachment to the tooth to a depth below the alveolar crest, that is, below the transseptal fibers. In no instance was an irreversible defect in the epithelial attachment found as a sequela of the surgical intervention. Sulcular depth, as measured with a periodontal probe, was recorded to have remained unchanged before surgical intervention and after healing. Tissue repair following surgical intervention was clinically complete in 5 to 7 days. The zone of attached gingiva neither increased nor decreased following the surgical procedures.

During the 3-month postoperative observation period, in which no mechanical retention device was employed, negligible rotational relapse occurred, even in the case of teeth that were earlier observed to have relapsed.

Discussion

The clinical study described here was formulated on premises which have been documented in earlier investigations:

1. Alveolar bone and the periodontal ligament surrounding the teeth reorganizes rapidly (in 50 to 80 days of retention) to a stable relationship with a rotated tooth.
2. Relapse tendencies of rotated teeth are apparently inherent in the fibrous network of the periodontium above the marginal alveolar crest, be it in the collagen or in the elasticlike oxytalan fibers.
3. Prolonged retention of rotated teeth is ineffectual in producing a reorganization of the supracrestal fibers which are stretched and deviated during rotation.
4. Overrotation has not been shown a valid method of lessening

rotational relapse; nor is it predictable that an overrotated tooth will "relapse" the desired amount into good alignment.

5. No technique used to alleviate rotational relapse is acceptable in the human patient if it also damages the periodontium; thus, no surgical procedure that would result in a loss of the amount of fibrous or osseous support (gingivectomy, corticoectomy, etc.) was considered in this study.

Since the exact mechanism by which the periodontium permits the orthodontic rotation of a tooth is not completely understood, it is difficult to explain fully the apparent success of a surgical technique in alleviating the relapse of rotated teeth. Perhaps the most productive explanation of relapse involves the elasticlike oxytalan fibers, especially since these fibers seem to be more numerous or more clearly defined in the periodontiums of rotated teeth.[2, 7-11] Most reports emphasize the fact that a predominance of oxytalan fibers are located in the locale of the epithelial attachment and transseptal fibers.[2, 7, 12] Thus, one is tempted to speculate that the surgical detachment of these fibers is the key to the success of the surgical technique studied in this report.

Nevertheless, although there does now appear to be a simple method of alleviating much of the relapse problem of orthodontically rotated teeth, there are still many unanswered questions as to *how* the relapse tendency is lessened. The surgical procedure described in this article does not appear to cause any damage to the periodontiums of teen-aged patients, but it has not been shown that the epithelial attachment of adult patients has the same regenerative capabilities.

In any case, the observations made during this investigation would clearly indicate that the surgical technique described here is clinically successful in reducing the relapse of orthodontically rotated teeth. In fact, the surgical technique is so simple and the complications so few that it could easily be used as a routine part of every orthodontist's retention therapy.

Conclusions

A simple surgical method of severing all supracrestal fibrous attachment to a rotated tooth has been demonstrated to significantly alleviate relapse following rotation, with no apparent damage to the supporting structures of the teeth.

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