The differences between the recently marketed nickel-chromium crown and other crowns available for primary posterior teeth are compared. Indications for use of preformed crowns are reviewed and techniques of tooth preparation, crown adaptation, and cementation are described.

Recent technological advances have resulted in a nickel-chromium alloy crown (Ionom/Ni-Chro) that can ease restoration of posterior primary teeth. The crown permits a simplified placement technique, readily learned by the student or practitioner of dentistry, that can conserve operating time.

Since their introduction in 1950,1 preformed molar crowns have been an important part of the armamentarium of dentists providing care for children. The recently introduced crown is another in a series of improvements made to the original concept. This paper compares the three types of crowns that are available for use today (Fig 1); the advantages of the nickel-chromium crown are indicated.

Comparison of preformed molar crowns

The first preformed crown (Rocky Mountain) marketed in the early 1950s, had straight sides and was considerably longer than the average tooth. The stainless steel was not strain-hardened before placement; this was accomplished during adaptation to the tooth. Considerable trimming, contouring, crimping, and finishing were required in placement of this crown. In the early 1960s, a significantly improved crown (Unit 

Although basically straight, the buccal and lingual walls of the crown were slightly contoured at the occlusal third to correspond to the anatomy of the tooth. The crowns were somewhat strain-hardened in manufacture and became more so during adaptation. With this technique, the margins generally required trimming with subsequent contouring, crimping, and finishing. Although an improvement in simplicity of application over the previously available crown, the same steps were necessary.

The recently introduced nickel-chromium crown2 differs distinctly from the earlier crowns. It is manufactured from the alloy Inconel 600, which is composed of 72% nickel, 14% to 17% chromium, and 6% to 10% iron, with trace amounts of other elements. Because the amount of iron is so small, Inconel 600 is not considered a stainless

steal. The other available preformed crowns are stainless steel, composed of iron (67%), nickel (10% to 13%), chromium (17% to 19%), and minor elements (4%). The metallurgical characteristics of the nickel-chromium crown allows these crows to be fully shaped and strain-hardened without defect during manufacture—something not possible with stainless steel. These nickel-chromium crowns are manufactured to correspond more closely to the actual anatomic crown height and, therefore, seldom require trimming. They are fastened, contoured in the middle third, and cramped at the cervical margin. They do require modifications when being adapted to the tooth but significantly fewer than are necessary for the older crowns.

### Indications

Preformed nickel-chromium crowns are indicated for restoration of posterior primary teeth in the following circumstances:

- When a clinically acceptable amalgam restoration, capable of remaining in the primary tooth until its exfoliation, cannot be placed. Although clinicians have varying opinions as to when a primary tooth is not restorable with amalgam, the following circumstances must be considered:
  - Interproximal caries which, when removed, would result in either wall of the proximal box being extended beyond the anatomic line angles.
  - Caries on the mesial surface of the maxillary or mandibular first molar. The unique configuration of the mesial surface of this tooth and the proximity of the pulp make placement of an acceptable amalgam restoration difficult.
  - Teeth so severely affected by the carious process that several surfaces have been destroyed. Enough tooth structure must remain to develop structurally sound walls for an amalgam restoration. Caries on three or more surfaces generally dictates the placement of a crown.
  - Primary teeth with developmental defects. Abnormalities in development such as amelogenesis imperfecta will generally affect large surfaces of the crown, making eradication and restoration with an amalgam impossible.

- After pulpal therapy. After such procedures, the tooth tends to become brittle because of fluid loss and is likely to fracture. The placement of an extracoronal restoration, such as a crown, protects against this.

- If the patient has a high susceptibility to caries, manifested either by numerous, gross carious lesions or by rampant caries. A nickel-chromium crown, by covering the clinical crown of the tooth, effectively prevents caries from recurring.

Preformed crowns have been advocated for use in other circumstances; however, they are not the preferred restoration for:

- Primary posterior teeth in which conservative amalgam restorations can be placed. With increasing frequency, practitioners place preformed crowns on any primary posterior tooth with a carious lesion. Quality amalgam restorations continue to be the preferred restoration in many primary molars.

- Teeth to be exfoliated within a brief period, six to 12 months. The cost-effectiveness of any restoration should be considered in treatment planning; in many instances, a temporary restoration can be placed in molars approaching exfoliation.

- Abutments for space maintainers. The preformed crown should be considered as a means of restoring a primary tooth, not as a method of fabricating a space management appliance. Bands can be placed on primary teeth to fabricate appliances to preserve arch circumference, a more conservative measure than reducing a tooth for crown placement. Even when the adjacent tooth requires crown placement, it is advisable to maintain separate functions. A well-placed crown can have a band and loop device cemented to it rather than have the loop directly appended to the crown. When the space management device has served its purpose, it can be removed readily, leaving the crown intact and undamaged. The use of crowns as abutments for space maintainers can result in poor adaptation of the crown to the tooth to accommodate the demands of the space maintainer. In addition, cutting the space maintainer from the crown leaves a roughened surface, a nidus for plaque development.

Preformed metal crowns have also been manufactured for anterior primary teeth and permanent first molars. It is probable that alternative restorations, such as resin systems or pin-
Technique

The technique for restoring a posterior primary tooth with a nickel-chromium crown is performed in the following stages: preparation of the tooth; section and seating of the crown; and adaptation of the crown and cementation.

Preparation of the tooth

After administering profound local anesthesia and placing a quadrant rubber dam, the clinician may begin preparing the tooth for restoration. A 60L or 160L bur is used to reduce the occlusal surface by 1.5 to 2.0 mm, following the cuspal outline and maintaining the original contour of the cusps (Fig 2). The bur is used on its side with the end pointing toward the central groove. The cusps are reduced by sweeping the bur back and forth mesiodistally. In severely broken-down teeth, much of the occlusal surface has already been lost. Only that amount of the occlusal surface necessary to bring the surface 1.5 to 2.0 mm below its original level should be reduced. This can best be judged by comparison with the marginal ridges of the adjacent teeth.

Next, the proximal surfaces are reduced. Wooden wedges are placed in the interproximal embrasures. The wedges separate the adjacent teeth, thereby minimizing the risk of damaging the tooth enamel. The wedges also provide for increased retraction of the gingiva and rubber dam. The bur is swept buccolingually across the proximal surface, beginning at the marginal ridge and at an angle slightly convergent to the occlusal surface. The bur should also follow a path tangential to the direction of the proximal surface (Fig 3). The depth of the slice should be sufficient to break contact with the adjacent tooth (Fig 4) and develop a finish line below any existing caries (Fig 5). Care must be taken to extend the preparation gingivally far enough to avoid the development of a ledge (Fig 6), which would make it difficult to seat the crown properly. Because of the cervical constriction of the primary tooth, adequate depth of the proximal preparation will result in a knife-edge finish line.

All line angles created by the occlusal and proximal reductions are now rounded. The occlusobuccal and lingual surfaces are beveled by moving the bur at a 45° angle to the occlusal surface.
preparation (Fig 7, 8). The distolingual and buccal surfaces and mesiolingual and buccal surfaces are rounded slightly into the proximal preparations to eliminate sharpness (Fig 9).

Finally, any remaining caries or amalgam restoration is removed. Appropriate pulpal protection is provided by a calcium hydroxide base or pulpal therapy, if indicated, is performed. The completed prepared tooth is shown in Figure 10.

The preparation of the tooth to receive a crown can be judged satisfactory if the following criteria are met: the occlusal surface is reduced by 1.5 to 2.0 mm, following the original contour of the tooth (evaluated by comparing marginal ridge heights), contact with the adjacent teeth is broken (evaluated by passing an explorer through the interproximal aspect at the gingival). The proximal slices are slightly convergent to the occlusal surface; end in a feather edge, cervical to any excavated cavities; and are flat and smooth and follow the original direction of the proximal surfaces before preparation. The occlusobuccal and lingual line angles and the four line angles formed by the proximal preparations with the buccal and lingual surfaces are rounded. If, finally, all caries or remaining amalgam have been removed, and appropriate pulpal therapy has been provided, the crown may be placed.

The rubber dam should remain in place until cementation, although it may be removed after tooth preparation is completed if it interferes with the seating and adaptation of the crown. The rubber dam prevents accidental swallowing or aspiration of a crown. If it is necessary to remove the dam, the practitioner should be extremely cautious while manipulating the crown in the mouth, especially while taking the crown off the tooth. If the crown is held on the crown's occlusal surface, the crown may be grasped, once disengaged from the tooth.

Selection and seating of the crown

Six sizes of nickel-chromium preformed crowns for primary molars are available for adaptation to the tooth. The crown must be large enough to fit over the height of contour of the tooth and around the cervical, but not so large that crimping of the crown will not result in a tight fit. The crown must also approximate the mesiodistal width of the tooth before preparation. Although both dimensions are variable, the circumferential height and the space available for crown placement are frequently altered by the various processes. Adjustments can be made for this by altering the mesiodistal width of the crown. The circumferential height of the tooth at the cervical is relatively unaffected by these variables. As the crown must be adapted closely to the tooth in this area, its size in relationship to the tooth is important. Crowns are manufactured so that the length is proportional to the mesiodistal and circumferential measurements. A crown selected for these variables will generally be the appropriate length, although it is sometimes necessary to increase or decrease the crown length in selected areas.

It is generally advisable to select a medium-sized crown such as a no. 4 and progress to a larger or smaller crown as required. The correct crown will approximate the mesiodistal width and the circumference of the tooth, having been placed with some resistance and yet completely enveloping the tooth at the cervical aspect. The properly seated crown will correspond to the marginal ridge height of the adjacent teeth and is not rotated on the tooth.

Adaptation of the crown

Because contouring and crimping of the preformed nickel-chromium crown have been accomplished in manufacture, relatively few adjustments are required of the crown. This is particularly true when only relatively minor destruction of the tooth's crown has occurred. Generally, the adjustments that are required to achieve a clinically acceptable crown can be made with no. 118 pliers. Adjustments usually involve modifying the buccal aspect of the crown in the cervical third and at the margin to adapt it more closely to the tooth structure (Fig 11). Fine adjustments at the proximal margins must sometimes be made to ensure a tightly fitting crown. The crown should adapt to the walls of the tooth on the buccal, lingual, mesial, and distal surfaces; when they are present. This stabilizes the crown and prevents its rocking on the tooth. It is possible to develop an apparently tight fit at the cervical and still have an unstable crown because there is not enough contact between opposing walls. Instability of a crown in the mesiodistal or buccolingual dimensions can be corrected by more closely adapting the...
Special circumstances

DECREASE IN ARCH CIRCUMFERENCE.

Frequently, structure of teeth has been lost through caries. This loss of contact causes adjacent teeth to shift into the space normally occupied by the tooth to be restored. When this occurs, the crown required to fit over the height of contour and at the cervical aspect will be too wide mesiodistally to be placed. Sometimes the crown can be seated, but only after it has been rotated on the tooth to the buccal or lingual aspect to compensate. A crown selected to fit the available mesiodistal space will be too small in circumference. When this occurs, a large crown, which would have fit the tooth, is selected and reduced mesiodistally. This is accomplished by grasping the marginal ridges of the crown with the Howe utility pliers and squeezing the crown, thereby reducing the mesiodistal dimension. Care must be taken not to exert excessive pressure or the proximal well(s) may collapse. This can be avoided by placing an insert that will maintain the crown’s basic shape while permitting some collapsing of the walls in the mesiodistal dimension. Should collapse occur, the walls of the crown can be recontoured with no. 116 pliers. The reduction of the mesiodistal dimension will, of course, expand the crown buccolingually and will necessitate considerable recontouring of the crown to the buccal and lingual walls of the tooth.

ADJUSTING CROWN LENGTH.

It is sometimes necessary to adjust the length of the nickel-chromium preformed crown. The crown may be too long, extending more than 1 mm below the gingival crest and impinging on the gingival attachment, as manifested by excessive blanching of the gingival tissues. When this occurs, it is necessary to trim the excess with small crown and bridge scissors. Because this leaves the edge of the crown somewhat jagged and rough, the margin must be smoothed with a rubber wheel and with fine abrasives, such as tripoli on a soft-bristle wheel and rouge on a felt wheel.

Occasionally, a deep carious lesion will extend so far down the proximal surface that the crown will be too short to cover this area and provide an adequate seal. This problem may be overcome by welding a small strip of .004 inch band material to the crown in the area of the inadequacy. The band material is then trimmed and adapted to the appropriate length and contour.

The margin between the band material and the crown is reduced and blended with a rubber wheel and polished with fine abrasives, leaving a smooth, almost imperceptible, juncture.

ADJUSTING CROWN CIRCUMFERENCE.

When the tooth is too large or too small for the available preformed crown, it is necessary to modify the crown circumference. To reduce crown circumference, a cut is made up the buccal surface to the occlusal surface. The cut edges are reapportioned to overlap one another, making the crown circumference smaller. The crown is then tried on the tooth, and the amount of overlapping necessary marked in a line on the crown. The overlapped edges are then spot-welded, and the cervical edge is trimmed with scissors if necessary. The juncture of the overlapping is blended with a rubber wheel and polished with fine abrasives.
Crown held stable

Fig 11 — No. 118 orthodontic pliers used to modify cervical third of crown.

Fig 12 — No. 112 ball and socket pliers squeezed to produce contact.

walls to these surfaces of the teeth. Crowns will be more difficult to place (require more adjustment) on teeth that have lost considerable amounts of coronal structure. Generally, contact with the adjacent teeth will be restored in the process of placing the preformed crown. If contact has not been restored and it existed before restoration, it can be accomplished by enhancing the proximal contour(s) of the crown with no. 112 pliers (Fig 12). The adapted crown is shown in Figure 13.

When properly adapted, the margins of the crown are approximately 1 mm subgingival. The crown should fit so tightly that there is no rocking on the tooth; moderate occlusal displacement forces performed with an explorer at the margin do not displace the crown; and no opening exists between the crown and the tooth at the cervical margins. The marginal ridges of the crown should correspond with the marginal ridges of the adjacent teeth. The crown should not be "canted" to the buccal or lingual aspect or "rotated" to the mesial or distal aspect in relationship to the adjacent teeth. Occlusion should be satisfactory when judged by interdigitation of adjacent and contralateral teeth.

After removal of the crown and before cementation, the crown margins should be viewed edge-on; the margins should be free of ripples or bends.

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Increasing the circumference of the crown is accomplished by cutting the buccal surface to the occlusal; separating the cut edges as needed, the degree determined by fitting on the tooth; and welding a piece of 0.04-inch band material across the cut surface of the crown. The juncture of band material and crown is finished as previously described. In cases of gross discrepancy, it may be necessary to cut a crown on both the buccal and lingual surfaces.

An alternative strategy for resolving the problem of inappropriate circumference is to use a crown by a different manufacturer. This, however, necessitates the maintenance of an additional inventory of crowns that are only infrequently used.

ADJACENT CROWNS. When restoring multiple primary molars in the same quadrant, it is advisable to reduce the adjacent proximal surface of the teeth being restored more than when only one tooth is restored. The greater reduction will ease the placement of crowns and the interproximal approximation. The more severe tooth reduction is necessitated by the loss of arch circumference, which occurs when the proximal surfaces of two adjacent teeth are affected.

Cementation

The crown can be cemented in place with a zinc phosphate or a polyacidic ester as cement. The crown is slightly overfilled with the cement and placed on the thoroughly dried tooth. Usually, the crown will be seated more easily than during adaptation due to the lubricating action of the cement. Cement should be expressed around all the crown margins; this ensures that all the space between crown and tooth has been completely filled by cement, thereby effecting a good seal. When partially set, the excess cement is removed by an excavator or explorer. The interproximal area is cleaned of excess cement by tying a knot in a piece of dental floss and drawing it through. Water and air are used to flush and clean the crown. Cementation is judged successful if the crown is cemented to the position originally adapted to on the tooth; expressed cement can be seen all around the margins; and no excess cement remains.

Discussion

The nickel-chromium preformed crown has been criticized in comparison with available varieties of stainless steel crowns.

First, the nickel-chromium crown is said to have a deep occlusal anatomy, in contrast with other crowns and with the natural primary teeth, which requires unnecessary occlusal reduction and may interfere with lateral excursions of the dentition. The occlusal anatomy of the nickel-chromium crown is shallower than that of the natural primary tooth. Sample measurements of occlusal depths of the two popular types of crowns indicated considerable variation; in some instances, the occlusal depth was greater on the nickel-chromium crown and, in others, on the stainless steel crown. However, the differences were no greater than 0.01 inch and cannot be considered clinically significant. It is possible that an optical illusion, created by supplemental grooves intended to replicate the morphology of the natural tooth, causes the nickel-chromium crown to be perceived as having a deeper occlusal anatomy. Nevertheless, clinical experience has shown that the nickel-chromium crown does not require increased occlusal reduction. The question of occlusal disharmonies caused by crowns as the mandible moves into lateral excursions has never been studied relative to the placement of any type of preformed crown.

A second criticism is that the highly contoured walls of the nickel-chromium crown require greater tooth reduction. Both types of crowns must ultimately be adapted into the cervical infrabulge area: the ability to accomplish this is a feature of the flexibility of the crown, not the degree of tooth reduction. The advocated technique of tooth preparation does not specify reduction of either the buccal or lingual surfaces. An exception to this is the existence of an especially prominent buccal bulge on the mandibular first primary molar. The crown springs over the height of contour because of its flexibility.

Third, it has been suggested that the nickel-chromium crowns are too short and leave enamel exposed and susceptible to caries. This criticism has not been validated by the author. If, in rare instances, a nickel-chromium crown was too short and other types of crowns were of adequate length, it would be preferable, nevertheless, to perform the aforementioned crown-lengthening procedure than to use a crown that routinely requires trimming and polishing.

Finally, it has been suggested the nickel-chromium crown is thinner than other crowns, resulting in more occlusal wear. Measurements of the two types of crowns indicated a wall thickness of 4.55 to 6.1 mil for the nickel-chromium crown and 5.6 to 7.1 mil for a typical stainless steel crown. (R. C. McCue, 3-M Co., personal communication). Thicknesses were fairly uniform throughout the crown with no indication of a thinning of the nickel-chromium crown at the cervical as had been suggested. The clinical significance of this difference is unknown. Vickers micro-hardness tests indicate the nickel-chromium crown to have a hardness of the magnitude of 325 to 350 compared with 250 to 306 for the stainless steel crown. Again, clinical experience has not substantiated the claim of increased occlusal wear of the nickel-chromium crown compared with the stainless steel crown.

Summary

When indicated, the nickel-chromium crown offers the clinician significant advantages over previously available crowns for the restoration of primary molars. Because of its flexibility and simplicity of application, the nickel-chromium crown should be considered in any instance in which a crown is indicated. A technique of preparation and placement is described, and objections to the crown are discussed.

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