Torque: A Round Wire Technique

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The advent of roentgenographic cephalometry as a clinical tool and the increase in orthodontic services have focused more attention on the edgewise arch mechanism. The desire for greater control with more ease has inspired many orthodontists to modify the original edgewise techniques, arches and bracket bands. The advertisements in our orthodontic journals attest to the myriad attachments and wires that have been introduced to facilitate the use of the edgewise technique, from, at first, rigid archwires to extremely light and flexible ones. Unfortunately, torque force, which is one of the essential qualities of the edgewise technique, has been neglected until recently.

Torque is defined as the force used in twisting a wire upon its long axis. In orthodontics the force delivered by the wire in untwisting itself is utilized to "torque teeth." Usually this type of force is used in a bucco (or labio) lingual direction for the purpose of altering the axial inclination of a tooth or teeth, for maintaining the specific axial inclination, or for anchorage during movement of other teeth. The terminology used describes the effect on the crown or root of the tooth. Hence, "labial crown torque" indicates a force which can produce a labial movement of the crown tip with a lingual movement of the root apex; the wire acts as the center of rotation.

A tooth in an edgewise assembly rarely undergoes one simple type of movement when a rectangular edgewise archwire is used. The forces resulting from minimal adjustments of this wire have been demonstrated to be near pathogenetic or excessive by Halderson, Johns and Moyers[1]. It is for this reason that clinicians using the edgewise mechanism start their cases with a series of light round wires. Some carry their cases to completion with round wires.

When a large number of teeth are ligated to an archwire, movements of the teeth may take place in several directions simultaneously. Gottlieb[2] first pointed out that these movements must provide a certain amount of resistance and interference to one another. Therefore, edgewise archwires attempting to effect forces with the three orders of bends are apt to nullify the desired movements of some teeth or produce undesirable movements of other teeth. Consequently, the archwires must be constructed with extreme exactness. In a clinical paper Graber[3] stated, "While the rewards of full banding and tooth control with rectangular arches are greater, the dangers are also more real. Torque force in one segment can cause unwanted reaction in another segment. In other words, there is a greater danger of the appliance working the orthodontist instead of the orthodontist working the appliance."

It is no wonder that Strang,[4] in his introduction to *"Tooth Movements By The Use Of Torque Force,"* wrote, "It is probably the power least understood and least frequently used by operators. It is, however, one of the most helpful of forces available, yet, at the same time, it is one of the most elusive, because it is so insidious and is often active when and where not expected."

The fact that one wire with various

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bends in it may cause unexpected forces prompted Atkinson[5] to develop the universal appliance which utilizes three distinct archwires. Later Carey[6] developed the sliding twin sections that separate the anterior torquing section from the posterior sections of the archwire. He also introduced a resilient edgewise technique to overcome the rigidity of the rectangular arch. Until 1954, these clinicians utilized flat wire for torque. In 1954 the author[7] introduced a method of torque with round wires, and Begg[8,9] presented the "loop method" of torque with round wire.

It is the purpose of this paper to present a simple technique for the edgewise mechanism whereby torque forces can be incorporated in round archwires with confidence and definite direction, for one or more teeth, and with a selection of anchorage. The forces used are gentle and can be utilized over a great distance to perform the three orders of movement.

This is not an attempt to alter the objectives of treatment by the operator, but to place at his disposal a simple adjunct to help in carrying out a complete treatment plan. This method can be adapted to Johnson twin arch techniques in selected cases.

Method

The edgewise technique is modified so that treatment can be carried to completion without the use of the rectangular wire. The standard edgewise brackets, .022 x .028 or the modified .022 x .032, are used in the narrow, siamese or molar widths. Bracket bands are placed on all teeth in the usual manner. The molar sheath is slit (Fig. 1) on the distal portion of the buccal surface for a distance of three or four millimeters.

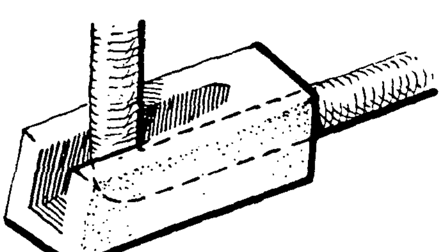

Fig. 1 Rectangular sheath with slit on distal portion of the buccal surface. A round wire has been bent into the slot.

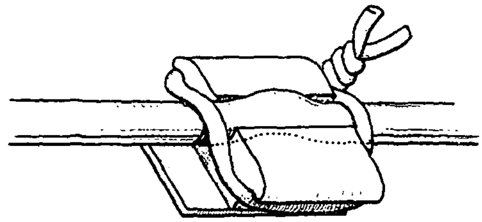

Fig. 2 Crimp tied into bracket. The bracket cannot move in mesial or distal direction relative to the wire.

Torquing or stabilizing bends are made by crimping the wire at the exact point that the wire will rest in the bracket when it is ligated in place (Fig. 2). The crimp serves as a key which fits in the bracket and prevents the wire from rotating within the slot. The crimp, which is made with a crimping plier (Howlett), endows the round wire with the properties of a rectangular wire in this area (Fig. 3). Torque is effected by holding the plier in such a way that it will create a crimp in the exact direction that the tooth is to be torqued. When the archwire is ligated, the crimp fits within the bracket.

Each crimp shortens the archwire by 0.3 mm; round wires from .016 to .022 inch in diameter may be used. The wire is bent to the desired arch form and the torquing crimps are made by

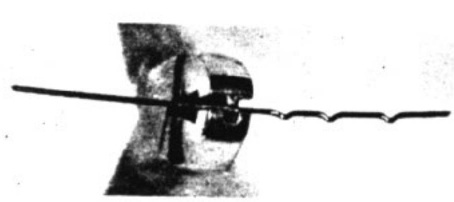

Fig 3

starting with the central incisors and working distally. Both pairs of crimps, left and right, are marked in the mouth and are made simultaneously. The wire must be reinserted and marked for each succeeding pair. If the wire tends to flatten in the region of a crimp, it can be recontoured with finger pressure before being returned to the mouth. If necessary, a vertical loop bent in the archwire can serve to compensate for the shortening of the wire. It should be noted that all teeth do not require torquing and that a crimp need not be made for those teeth that are to be left passive or used for anchorage in a vertical direction. (The term "anchorage" is used to denote the source of reciprocal or resisting force.) This maintains the resiliency of the wire and permits the application of lighter and less pathogenetic forces for the movement of teeth. The wire is then heat-treated three minutes at 850°F. and slowly cooled.

With this technique the operator can resolve the various forces within one archwire. The first two orders of movement may be readily accomplished with the round wire; however, this method allows the operator to incorporate torque force with confidence and definite direction, in a simple manner, and with selection of anchorage. Anchorage is not dependent on the adjacent teeth. No compensating bends are required as with the rectangular archwire. The force used is gentle and acts over a long distance.

Archwires

The round archwire so constructed is very versatile and can be used for full or sectional arches. For example, tieback posts or loops can be bent in position; hooks may be soldered, welded or added to the arch on sheaths or by means of screw locks; a crimp in the archwire in the region of the lock eliminates slippage of the lock (sometimes a problem with a rectangular wire); coil springs or vertical loops can be used: and any standard edgewise auxiliary, including extraoral anchorage, may be adapted to the bands or archwire. Furthermore, a tooth that is tied into a crimp in the wire cannot slide along the wire. This eliminates the need for anchor spurs. Thus, two teeth can be separated with a coil spring between them, yet the movement can be controlled so that only one moves. This is done by tying one tooth to a crimp in the arch and allowing the other to slide freely along the wire. The reverse, bringing two teeth together, is also possible.

Sectional Archwires

The helical spring vertical loop is an effective type of spring used with these archwires and can be employed with full or sectional wires. The sectional archwire is a gentle appliance for moving canines distally. When a first premolar has been extracted, the archwire can be so constructed that the molar and second premolar are used as anchor teeth together or independently. If the premolar crimp is omitted, it is possible for the wire to slide through the bracket so that the molar absorbs the initial pressure. The crimp for the premolar is used in lieu of an anchor spur and can be arranged so that the premolar shares in the anchorage or supplies it entirely. The premolar crimp is located in such a way that it will occupy the premolar bracket after the sectional arch has been activated. Two crimps permit continued use of the same archwire as the space closes and the archwire slides farther into the molar sheath.

To open a space with a vertical loop, an open loop may be closed with ligature wire. This is accomplished by means of a crimp on each leg directed towards each other. After the arch is inserted, the ligature is cut releasing

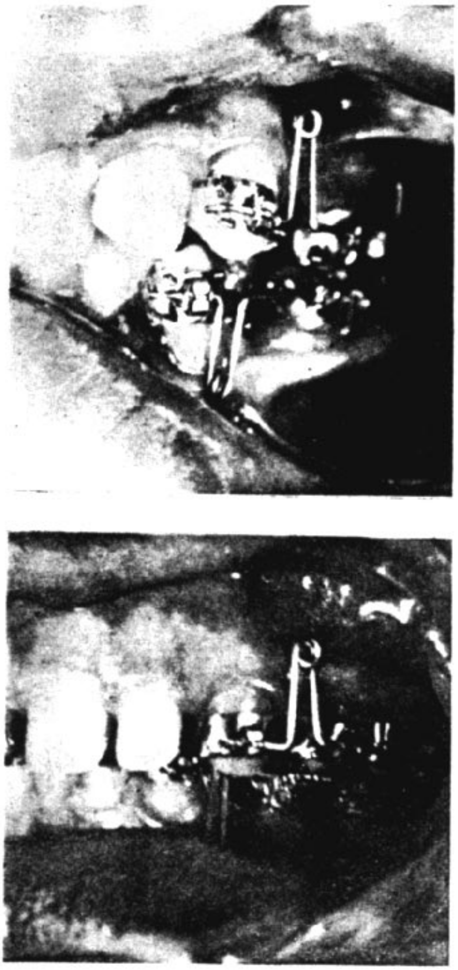

Fig. 4 Sectional archwire used to retract canine following extraction.

the spring. In sectional archwires, the tieback post may be eliminated in a similar manner. A crimp is placed on the distal leg of the vertical loop. This serves as an eyelet for exerting the desired force with a ligature tie without any interference from a post as it approximates the molar sheath. An open and closed loop combined may be used to move a segment of teeth en masse as described by Strang[1].

The use of sectional archwires to move canines into premolar extraction sites is shown in Figure 4. The patient had four first premolars removed and the canines were retracted with helical loop sectional archwires that fitted into edgewise bracket bands. A crimp was placed in the wire to prevent the rotation of the wire within the canine bracket and the loop made so as not to impinge on the soft tissues. Figure 4 above, shows the patient at the beginning of treatment and below twelve weeks later. A space has opened mesial to the canines as they move distally. The lateral incisor also shows improvement.

Full Archwires

The full archwire with crimps is an excellent way to demonstrate torque application. One of the most important applications of this method is retracting the maxillary incisors without tipping them lingually. The full archwire with helical loops is used to close spaces following extractions and to torque teeth. Figure 5 shows a maxillary archwire with helical spring loops, root paralleling bends and anterior crimps with labial torque. When this wire is inserted into the central incisor brac-

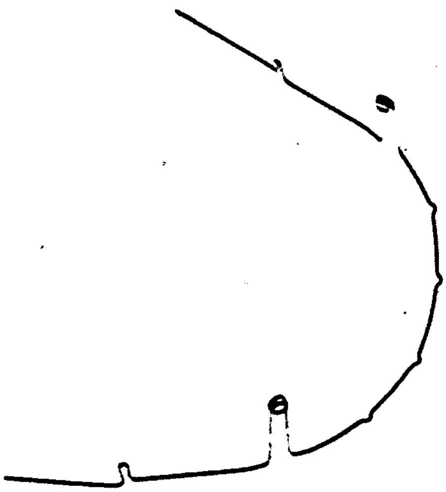

Fig. 5 Archwire with open helical loop springs, tieback posts and crimps for incisors.

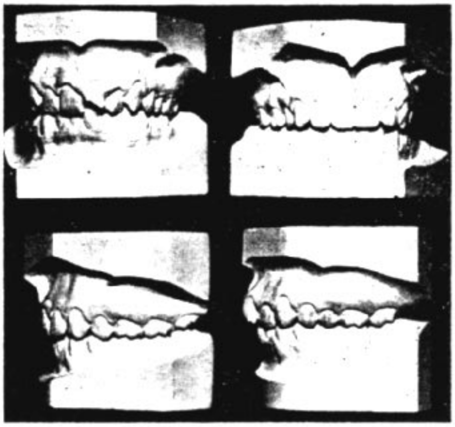

Fig. 6 Treatment with round wire only.

kets. the ends of the wire are displaced gingivally. This archwire is then equipped with hooks on screw locks for intermaxillary elastics.

A case treated in this manner is illustrated in Figure 6. The patient, a female sixteen years of age, had a Class I malocclusion. Four first premolars were extracted and the canines were retracted with sectional round archwires. The incisors were then moved lingually with round wires which had helical loops bent distal to the lateral incisor brackets and torquing crimps for the incisors. Total treatment time was twenty-three months. The four third molars erupted in excellent positions.

When levelling teeth in the edgewise technique with round wire resilient arches, horizontal crimps may be added to fit the incisor brackets. This prevents labial flaring of the incisors or can be used to apply torque force to the incisors. The following case demonstrates this.

The patient presented with palatally impacted maxillary canines. The four first premolars were removed by an oral surgeon *prior* to the patient's first visit to the orthodontist. This case was selected to illustrate torque because of the deep overbite and severe lingual

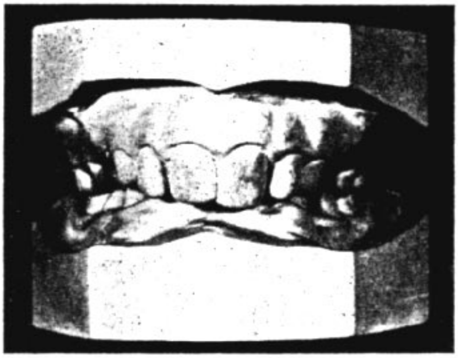

Fig. 7

inclination of the lower incisors. The casts at the beginning of treatment are shown in Figure 7.

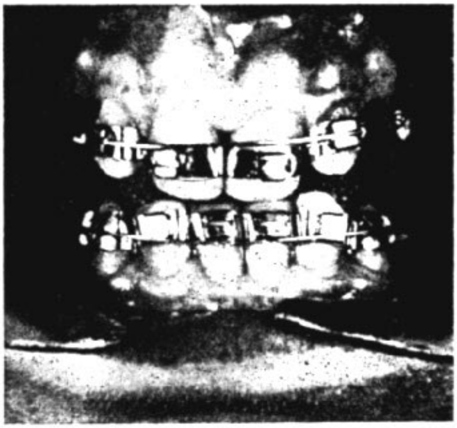

Fig. 8 .018 lower levelling arch with crimps for labial torque before ligation.

The lower canines were banded and retracted with sectional archwires. Following this procedure, the lower incisors were banded with .032 depth edgewise bracket bands, and an .018 levelling arch with labial torquing crimps was inserted (Fig. 8). This arch was replaced three weeks later with a similar .020 archwire. Since the maxillary canines were being moved into position during this period, no attempt was made to retract the maxillary incisors. The effect of torque forces on the lower incisors during levelling can

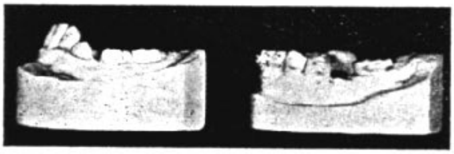

Fig. 9

be demonstrated in Figure 9 with casts of the lower teeth at the beginning of treatment and after the application of labial torque force for six weeks. There was a severe lingual inclination to the lower central incisors initially and the progress model shows the improved axial inclination of these teeth with a corresponding decrease in the alveolar plate over the malposed roots.

To verify and measure this change, a cephalometric film was taken at this time and tracings were made and compared with those made at the start of treatment. The tracings were compared according to the technique of Steiner[10, 11] to see if there was actual apical root movement resulting from the change in axial inclination of these teeth.

Tracing A, in Figure 10 shows the patient at the beginning of treatment. The line NB gives some indication of the anteroposterior relationship of the lower incisors. B and C tracings (Fig. 10) are from the film that corresponds to the progress model with the bands on the teeth. Superimpositions of the tracings were made on SN, with N registered, and Go-Gn, with D registered. The dotted line indicates the long axes of the incisors before treatment was started. When NS is superimposed, the apparent change in the axial inclination of the lower incisor is four degrees. However, when we superimpose on point D on the symphysis, the change in axial inclination is fourteen degrees and the root apex appears to have gone back with little forward flaring of the crown.

Molar Torque

If the last molar is to be torqued, or used for anchorage, the archwire is pulled into the distal slot described earlier. This prevents the wire from revolving within the sheath. After the archwire is bent into the slot from the distal, it is then cut flush with the buccal sheath and smoothed out so that it will not irritate the cheek. If the wire is bent gingivally before insertion into the slot, it will exert buccal crown torque on the molar, and if it is bent to the occlusal before insertion into the slot it will exert lingual crown torque. Figure 11 - left illustrates the anteroposterior view and Figure 11 - right

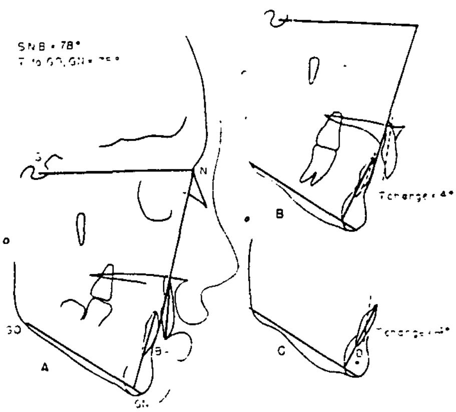

Fig. 10 Cephalometric tracing of patient T.S.

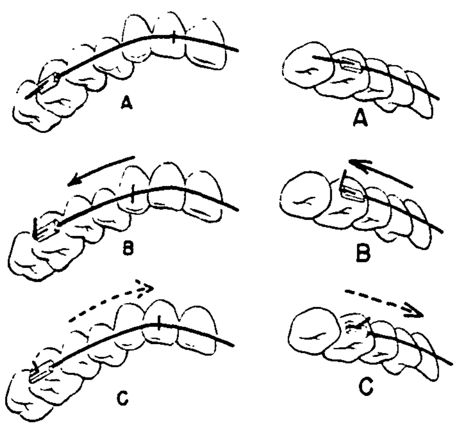

Fig. 11

the posteroanterior view of a round wire with reference to the molar sheath when active torque is applied to the molar. Figure 11A shows the wire passive in the molar sheath. Note the mark on the wire over the lateral incisor.

The wire is moved distally three or four millimeters and bent at right angles to the sheath, in a gingival direction, at the distal border of the sheath (Fig. 11B). The end of the wire is then twisted ninety degrees so that the bent end can slide forward into the slot (Fig. 11C). The mark on the wire over the lateral incisor is back in its former position. This exerts buccal torque on the molar.

If the other side requires similar activation, the wire must be equipped with a vertical loop which permits the wire to be stretched to the distal, then torqued and inserted into the molar slot. This also serves as additional force for torque applied to other teeth and will be described later in the analysis of torque.

Torque Analysis

In order to understand the forces involved let us consider the application of lingual crown torque to a canine using a round wire.

It is interesting to analyze the anchorage into its component forces. When lingual crown torque is applied to a canine with a round archwire, there is no tension on the posterior teeth on the same side as the canine. If the teeth have been levelled, the wire slides freely into the molar sheath and into the premolar brackets. However, the wire is displaced occlusally on the other side with the greatest deflection at the site of the molar sheath diagonally across from the canine to be torqued. This can be illustrated on a typodent with an edgewise assembly (Fig. 12). The wire opposite the adjacent lateral incisor has the least amount of vertical

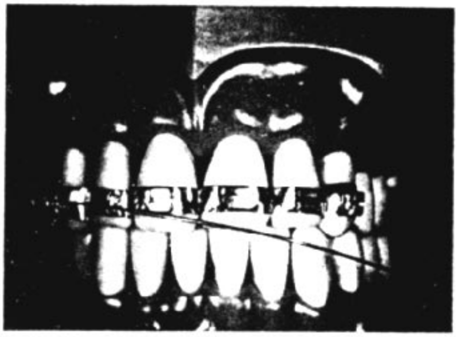

Fig. 12

displacement. If the archwire is ligated to all the teeth, the archwire acts as a lever using the teeth from the lateral around to the molar as the anchor teeth. The molar is in the most strategic position. The teeth may be used for anchorage selectively, if desired, by removing the bands from those teeth which we wish to eliminate from the arrangement. Note that torque force is obtained from anchorage forces in a vertical plane along the long axis of the teeth.

There is a certain amount of spiraling of the wire; this force expends itself gradually. If it is desired to use the spiral action of the wire in conjunction with the vertical component, it is necessary to crimp the wire and insert it into the other brackets or to pull the wire into the distal slot in the molar sheath. Figure 13 shows a lateral view of a typodent with an archwire

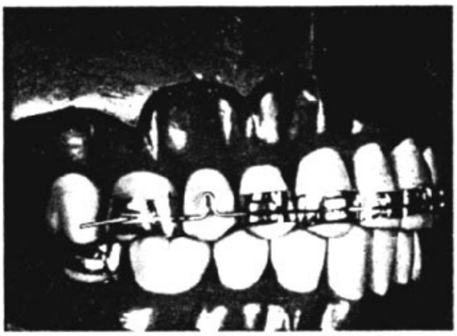

Fig. 13

which has a vertical tieback post bent in the wire and a crimp to torque the canine lingually. The crimp has not yet been inserted into the bracket. For purposes of illustration, the second premolar bands are removed. The bends in the wire show up more clearly against a light background.

The vertical tieback post or loop is deflected towards the premolar teeth when the torqued wire is inserted into the canine bracket (Fig. 14). When a horizontal crimp is inserted into the first premolar bracket the wire does not spiral, distal to the premolar. This is demonstrated by the lack of deflection of the post. Therefore, the premolar (and the lateral incisor, if engaged with a crimp) would bear the brunt of this force even when molars are included for anchorage. On the other hand, if no crimp is included for the premolars and the wire is pulled into the distal slot in the molar sheath, it will be found that the post deflects slightly. The molar also serves as anchorage for the twisting of the wire. The wire engaged into the molar sheath does not entirely eliminate the spiral action of the wire, as was the case when the premolar was used to resist the torque of the canine. This was also found to be true with rectangular wire which was not engaged into the premolar brackets. This is because a longer span of wire is twisted, in this case, than when a premolar is used for anchorage. Therefore, there is less force on the molar although the angle of rotation may be the same. With round wire it is possible to include or omit any units from torque anchorage in a very convenient and simple manner.

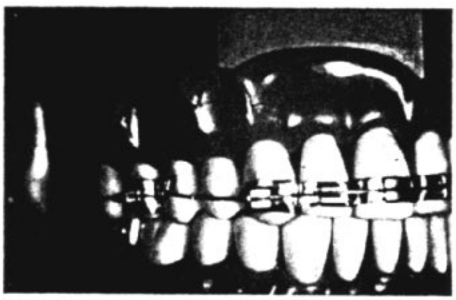

Fig. 14

If a rectangular archwire is used for this purpose careful and exacting bends are required to control the wire from unnecessary torque in the different segments. When the rectangular archwire is ligated to the teeth, the operator will find that the points of primary resistance to the torquing of the canine are at the adjacent premolar and lateral incisor. Therefore, undesirable torquing of these teeth may result. Only after these two teeth have moved will the teeth distal to cuspid and mesial to lateral serve as anchorage. In effect, this principle is explained by Strang[4] in his description of progressive torque.

This particular phase, torquing of one tooth, can be adapted to any technique that employs a buccal tube or sheath provided an edgewise bracket band is placed on the tooth to be torqued. Many operators who use the Johnson twin arch technique employ molar width or siamese edgewise bracket bands on the incisors. This permits them to change to the edgewise mechanism, if indicated, without replacing the incisor bands. If the incisors are inclined lingually, these teeth can be torqued be means of a round wire with labial torquing crimps. Since rigidity of the buccal sections is desired, .021 round wire is inserted into end tubes with hooks which, in turn, are placed into the round buccal tubes. A pinch in the end tubes limits the motion of the round wire within it.

Discussion

The amount of torque force exerted by a round wire may be compared to the force exerted by a rectangular wire made from the same material. The moment of torque per unit length, within the maximum shearing stress, for a round or rectangular wire is expressed by the following formulae adapted from Timoshenko[12]:

For round wire $$Mr = \frac{G\Delta d^4\pi}{32}$$

For rectangular wire $$Ms = G\Delta c^3bK$$

M = moment of torque, G = modulus of elasticity, Δ the angle of deflection, d = diameter of the round wire, b = large side of a rectangle and c = small side of a rectangle. K is a constant which depends on the relative sizes of the sides of a rectangle. For the sake of simplicity, a square wire will be used as an example; in this instance K = .141

By combining the two formulae,

the ratio $$\frac{Mr}{Ms} = \frac{\frac{G\Delta d^4\pi}{32}}{G\Delta c^4K} = \frac{\frac{d^4\pi}{32}}{.141c^4K} = \frac{1}{1.4}$$

is gotten when c = d.

From this formula it can be calculated that a square wire exerts 1.4 times as much torque per unit of length for the same angle of deflection as a round wire having the same modulus of elasticity and having a diameter equal to one of the sides of the square. To attain the same force as a square wire, a round wire would require the angle of deflection to be one-third greater within the limits of the maximum shearing stress.

Since the moment of torque is a function of the fourth power of the diameter, it can be calculated that an .021 wire exerts 1.9 times as much force as an .018 wire per unit of length. In other words, approximately 2 Δ deflection of an .018 wire will apply the same force as an .021 round wire with angular deflection Δ.

As the .018 wire with a deflection of 2 Δ recoils to Δ angular deflection, it still has Δ more to go after it has moved a tooth through Δ. Whereas an .021 wire going from Δ to zero starts with the same force and loses it abruptly. This demonstrates the advantage of light resilient wires which act over a long distance.

It also should be noted that the center or axis of rotation of the bracket changes .0015 inch when an .018 wire is placed in an .022 width bracket, as compared with an .021 wire in the .022 width bracket.

The following table gives approximate comparative values for the moment of torque for a square and round wire. Mt = moment of torque for angular deflection, Δ for an .018 round wire.

	round		square	
angle	.018	.021	.018	.021
Δ	Mt	1.9 Mt	1.4 Mt	2.7 Mt
2 Δ	2 Mt	3.8 Mt	2.8 Mt	5.3 Mt

Summary

A simple technique is described to effect torque forces with the edgewise mechanism. This method uses a round archwire with a suitable torquing crimp which endows the wire with the keying properties of a rectangular archwire in this area. It gives the torquing process exactness and definite direction with ease and simplicity and with a selection of anchorage. It can be adapted to other techniques which use buccal tubes or sheaths and anterior bands.

1455 Grand Concourse

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