Review Article

Torque in Orthodontics

Deepshikha[1], Ankur Chaukse[2], Kshitij Gupta[3], Mayur Soni[4], Gourav Patil[5], Abhideep Singhai[6]

From, [1,4,5,6]Postgraduate Student, [2]Professor, [3]Professor and Head, Department of Orthodontics, Rishiraj College of Dental Sciences and Research Centre, Opp. Raja Bhoj Airport, Gandhinagar, Bhopal, Madhya Pradesh, India- 462036.

Correspondence to: Dr. Deepshikha, Department of Orthodontics, Rishiraj College of Dental Sciences and Research Centre, Opp. Raja Bhoj Airport, Gandhinagar, Pipalner Road, Bhopal, Madhya Pradesh, India- 462036.
Email ID: deeps.mandal9@gmail.com

Received – 05 June 2020 *Initial Review – 15 June 2020* *Accepted – 09 July 2020*

ABSTRACT

Torque is a shear-based moment, a force obtained from a twisted spring wire in its effort to un-twist itself which causes rotation. In dentition, it pertains to facio-lingual root movement and control. Also, it refers to the amount of twist applied to an arch wire in bracket engagement or activation. Despite the advent of numerous treatment philosophies, appliance systems and torque prescriptions and considerable research done in the past, torque is still an enigma. The key is to understand not only how we reach where we are but also to learn how to manage the torque properly, focusing on the technical and biomechanical purposes that led to the change of the torque values over time. The present review focuses on application of torque in orthodontics.

Key words: *Inclination, bracket slot, prescriptions, torque*

For every person, lower third of the face and especially the anterior teeth are essential for social consent. Orthodontic treatment aims to position the teeth such that they achieve optimum aesthetics and function [1]. One of the criteria for obtaining a functional occlusion is to have ideal axial inclinations of all teeth at the end of active treatment. Torque is the force that allows the orthodontist to control the axial inclinations of teeth so as to place them in a balanced position. Torque is one of the most cardinal and formidable forces in orthodontics. Clinically, torque is the third key of the occlusion, and is said to be positive when the root is lingually positioned and negative when the root is facially positioned as compared to the crown [2]. Whereas, biomechanically it is the torsion of a rectangular archwire in the bracket slot. Rauch has defined torque as the force that provides the operator control over the movements of roots of teeth [3]. The objective of this article is to review the importance of torque in orthodontics and provide a brief description about torque in different appliance systems.

IMPORTANCE OF TORQUE

- **Effect on apical bases:** One of the objective of orthodontic treatment is reorientation of apical base relationship, maintaining good labial axial inclination of the upper incisors Torque assists the orthodontist in bringing about a desirable change of points A and B, thereafter the desirable facial changes [4].
- **Effect on teeth:** Proper bucco-lingual inclination of both posterior and anterior teeth is considered important in providing stability and for proper occlusal relationship in orthodontic treatment.
- **Smile esthetics:** Fullness of the smile should be sought through adjustment of the clinical crown torque of the maxillary canines and premolars to their most esthetic appearance in different face types [5].
- **Torque and root resorption:** Since the first comprehensive study on root resorption by Ketcham [6], most investigations have confirmed that root resorption is common after orthodontic treatment. In

mature young teeth, adult patients and periodontally compromised cases, a thin edgewise arch wire is preferred. The best technical solution to avoid root resorption in lightwire technique would be to apply a light torquing force that acts interruptedly [7].

TORQUE WITH REMOVABLE APPLIANCES

Although lingual tipping of upper anterior tooth roots is thought to be through fixed appliances, removable appliances have also been used in an attempt to bring about root movement [8]. Different types of torquing springs can be used which are flexible, easy to construct, easily positioned and adjusted. Bass (1975) has shown that it is possible to perform this movement by pressure in a lingual direction at the gingival margin on the incisors using a double cantilever spring while preventing lingual movement at the incisal edges using a Sved bite-plane (Figure 1). A box type attachment was used by Watkin (1933) for his modification of the pin and tube appliance for root movement and a box attachment in stainless steel was described by Friel and McKeag (1938) to induce torque. This box was well known as the McKeag Box [8].

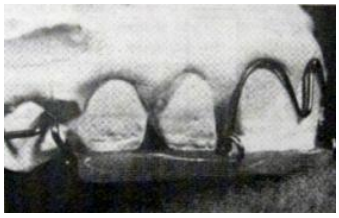


Figure 1: Lingual root torque on upper incisors using a removable appliance

TORQUE WITH THE EDGEWISE APPLIANCE

The contribution of the edgewise mechanism towards attaining the objectives of orthodontic treatment is complete control over the axial inclination of all the teeth in all directions by engagement of the arch wire in the slot of the bracket on the tooth [9]. The Edgewise mechanics torques teeth buccally or lingually by placing an activated rectangular wire in a rectangular bracket slot. However, the immediately adjacent teeth receive the equal and opposite reciprocals, which are commonly disregarded. The consequence is a decrease in the facio-lingual discrepancy between adjacent teeth. Twists in rectangular arch wires seem to be suitable only when reciprocal torque is needed on the adjacent teeth, but one should be aware of high moments emerging in full-sized or nearly full-sized stainless-steel arch wires.

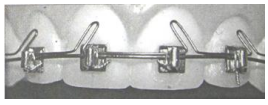
These problems can be overcome by using under-sized wires for torque, using torquing arches which is designed to place concurrent third-order couples on one or more incisors when treating all of these teeth as one big tooth and one big bracket. The second bracket in this two-couple system is at the molar [10]. Including torquing spurs in round-base arch wires and use of Warren springs also helps overcome the problem encountered with edgewise appliance torque [11]. Torque control in finishing stages can be obtained by maintaining a proper moment/force ratio during the time of retraction in extraction cases [12]. As the original edgewise bracket comprises of a cut at the slot right angle to the base, the rectangular arch wire must be twisted to procure correct crown-root inclinations. To overcome this, torqued slot brackets were introduced by manufacturers in the late 1950s or early 1960s. This design eliminated the need for adding torque to the anterior portion of the upper arch wire [13].

TORQUE WITH THE BEGG TECHNIQUE

Since 1961, the Begg technique has been divided into three treatment stages. In most patients, it becomes quite evident by the end of the second stage of treatment if it is required to torque incisor roots lingually [14]. In begg's method, the reactions generated by the torquing auxiliaries spread through the arch wire on to the entire arch, rather than predominantly expressing on the adjacent teeth as in edgewise appliance. Originally spurs were bent into the main maxillary archwire which was made from 0.016-inch archwire material, to rest against the labial surfaces of the upper central and lateral incisors. The torque force was relayed in a spiral manner along the main archwire to the anchor molars [15].

Different types of torquing auxillary

- The four-spur type auxiliary (Figure 2) is still the most popular with orthodontists practicing the Begg light wire technique. The auxiliary is made from 0.012" Premium Plus wire. However, if only the central incisors require the torque, an auxiliary with two spurs is used as shown in Figure 3.



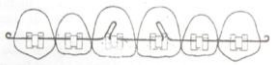


Figure 2: Four spur torquing auxiliary, Figure 3: Two spur torquing auxiliary (Von Der Heydtauxillary)

- Pre-wound torquing auxiliary/ rat-trap type auxiliary (Figure 4), originally devised by Dr Begg in early 1950's. Regardless of the size of wire used in its construction, it is simpler to apply and has the potential to deliver a large force through a greater range of movement than other types of incisor torquing auxiliaries [15].
- Kitchton's torquing auxiliary was invented by Dr. John Kitchton, (Figure 5) is capable of exerting a great amount of force. It can be made to include central and lateral incisors, or it can be shortened to torque central incisors only [16].

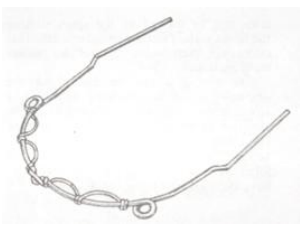
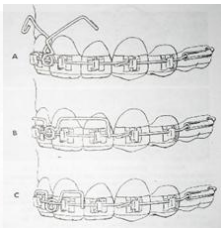



Figure 4: Pre-wound torquing auxiliary, Figure 5: Kitchton's torquing auxiliary

- For any tooth requiring root torque in the labial or lingual direction, single root-torquing auxiliary proposed by Kesling is a very useful design (Figure 6). It is indicated in case of an upper premolar, which needs buccal root torque to eliminate cuspal interference from its hanging palatal cusp [15].

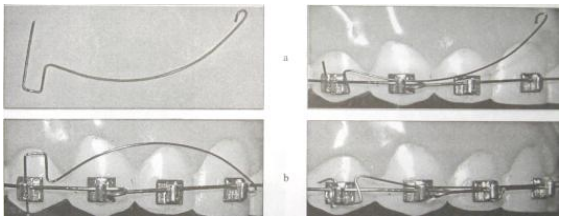


Figure 6: Single root torquing auxiliary

- Reciprocal torquing auxiliary (SPEC design) is used in cases where two adjacent teeth require root torque in opposite directions (Figure 7). The 'Spec' auxiliary could be used for controlling the root movements during the first and second stages if made in lighter 0.009" or 0.010" size wires [15].

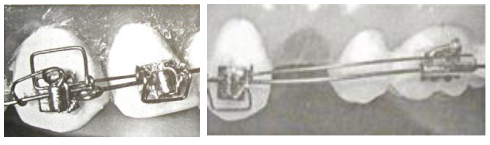


Figure 7: Spec auxiliary with cross-over bends, Figure 8: Activated Tan auxiliary pressing against the incisal portion of canine

- Franciskus Tan described reverse torqueing auxiliary for controlling the roots of canines or pre-molars design in the 1987 (Figure 8). It was reported for the labial root movement of a palatally impacted maxillary canine, whose crown has been aligned but the root is placed palatally and requires labial root torque [17].
- Mollenhauer's aligning auxiliary (MAA) (Figure 9) strives root control from the very beginning, without notably affecting the anchorage and overbite correction, can be used in crowded teeth. This is achieved by using a combination of a stiff base arch wire made from 0.018" Premium plus, and ultra-light root moving forces from the MAA made from the 0.009" supreme grade wire. It can be used after the stage I as the braking mechanism by adding more positive torque into the MAA. In growing brachyfacial cases, labial root torque on the lower incisors can be applied to prevent lingual movement of their root. Whereas, in controlling the mesiodistal root position, a ligature wire is tied to the auxiliary and to the pin to transfer the tipping effect to the tooth [18].

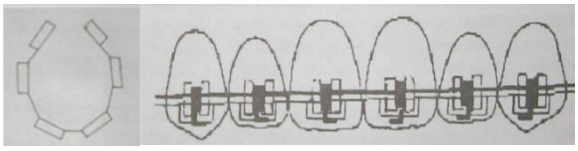


Figure 9: Mollenhauer's Aligning Auxiliary (MAA)

TORQUE PRESCRIPTIONS WITH EDGEWISE APPLIANCE (PEA)

- **The Roth prescription:** Ronald Roth began to use the straight wire appliance in 1970 when Andrews gave him the first set of high cost prototype brackets that were welded into pinched band material [19]. Since these had inventory problem and Anchorage loss, Roth in 1979 introduced a bracket setup with modified tip, torque, rotations and in out movement of the Andrews standard setup brackets (Table1), These second generation of pre-adjusted brackets had more torque in the maxillary incisors which improves esthetics, provides more space for lower anterior teeth, and establishes proper anterior guidance [20].
- **The Vari-simplex discipline:** This system was developed and introduced by Dr. R.G. Wick Alexander and is based on edgewise philosophy. Here, '*Vari*' refers to the variety of bracket types used (Twin, Lewis and Lang) and *'Simple*x' refers to the principle of KISS (Keep it simple, sir) [21].

- **The Bio-progressive system:** This was introduced by Dr. Robert Ricketts and Ruel Bench who combined contemporary edgewise mechanics with solid diagnostic principles and a new approach to sectional mechanics [22].
- **MBT^{TM} bracket system:** McLaughlin and Bennett worked with Trevisi to re-design the Straight Wire Appliance (SWA) bracket system to complement their treatment philosophy and to overcome the perceived inadequacies of the original SWA. They re-examined Andrews' original findings and considered additional research input from Japanese sources when designing the third generation of pre-adjusted brackets namely, the MBT^{TM} system. Due to the small area of torque application, the pre adjusted appliance system is relatively inefficiency in delivering torque, it is therefore necessary to build in extra torque into the important incisor and molar brackets to achieve the clinical goals with minimum of wire bending [23].

TORQUE IN BASE VERSUS TORQUE IN FACE

According to Andrews, torque in the base is a pre-requisite for a fully programmed appliance that produces acceptable results without arch wire bends, assuming the brackets are placed correctly [24]. The design of brackets is such that the LA point, the base point and the slot point were on the same horizontal plane. This is achieved with an acute angle at the occlusal aspect of the bracket base and an obtuse (>90^0) angle at the gingival aspect of the bracket base [23]. It is apparent that brackets with torque in face do not fulfill the strict criteria laid down by the straight wire appliance as the slot axis will no longer coincide with the base point and FA point (Figure 10). Using computer designing, the modern bracket systems provide more flexibility of design, not just to place the slots in the correct position in the brackets, but also to improve bracket strength and features like tie-wing depth and labio-lingual profile. The brackets may either be finished with all torque-in-base (full size and clear) or with amalgamation of torque-in-base and torque-in-face (mid-size) with no difference in slot position [23].

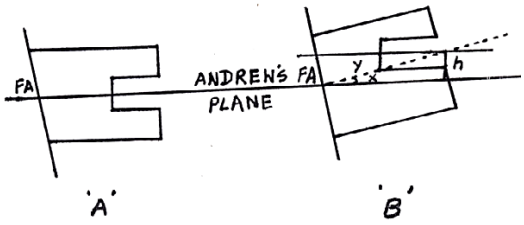


Figure 10: Torque-in-base and Torque-in-face

TORQUE WITH THE MODERN BEGG TECHNIQUE

Combination anchorage technique by Thompson is designed to broaden the treatment effectiveness of the orthodontist. Dual-flex wires - combination of arch wires such as Dual Flex 1 and 2, reduces the use of loops in the Phase I bite-opening alignment and retraction mechanics. These are multi-segment wires with round 0.016-inch stainless steel in the posterior section and round 0.016-inch nickel-titanium (Titanal) in the anterior section. In situations that need heavy anterior resistance to reduce lingual movement of anterior teeth, a Dual Flex 2 wire can be used. This wire has a round 0.018inch stainless steel posterior segment and 0.016inch * 0.022-inch nickel-titanium anterior segment from canine to canine [25].

Table 1: Tip and torque values of various prescriptions

Torque prescription	Tooth	Central incisor	Lateral incisor	Canine	1st premolar	2nd premolar	1st molar	2nd molar
The Roth prescription	*Maxilla*	12°	8°	-2°	-7°	-7°	-14°	-14°
	Mandible	-1°	-1°	-11°	-17°	-22°	-30°	-30°
The Vari-simplex discipline	*Maxilla*	14°	7°	-3°	-7°	-7°	-10°	-10°
	Mandible	-5°	-5°	-7°	-11°	-17°	-22°	-27°
The Bio-progressive system	*Maxilla*	22°	14°	7°	-7°	-7°	-10°	-10°
	Mandible	-1°	-1°	-7°	-11°	-17°	-27°	-27°
MBT^{TM} bracket system	*Maxilla*	17°	10°	-7°,0°,+7°	-7°	-7°	-14°	-14°
	Mandible	-6°	-6°	-6°,0°,+6°	-12°	-17°	-20°	-10°

TORQUE WITH THE LINGUAL APPLIANCE

The development of fixed lingual orthodontic appliances began in the mid-1970s, largely because of an increased interest in adult orthodontics as a result of esthetic concerns [26]. Lingual light wire technique was a significant advancement over the conventional labial Begg technique considering the esthetic aspects of the appliance. Fujita rooted that with brackets placed on the lingual side, orthodontic treatment is possible, with an improvement in esthetics and increased patient acceptance [27]. Stephen Paige used two separate effective methods such as a torquing auxillary and torqued ribbon arch for torque control (Figure 11). A torquing auxiliary is similar to the auxillary in conventional Begg mechanotherapy. The application of force on the tooth is at the incisal edge [28].

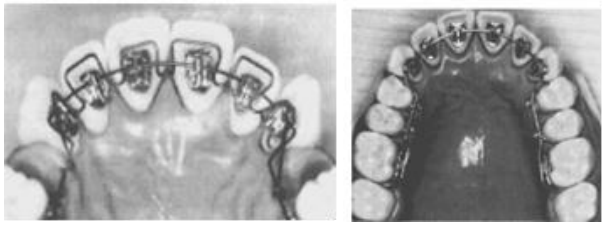


Figure 11: Torquing auxiliary and Torqued ribbon arch for lingual light wire technique.

TORQUE WITH CLEAR PLASTIC APPLIANCES

Clear plastic tooth moving appliances are excellent options for those patients with mild to moderate alignment problems, who are reluctant to wear fixed appliances. Essix tooth movement is a distinctive bio-mechanical system with the use of a removable plastic appliance that is thin, sturdy and practically invisible [29]. The efficiency of essix-induced torque is more compared to the edgewise brackets because it is only the length of the clinical crown measured in millimeters that limits the distance between the opposing moments instead of the width of a rectangular bracket slot measured in thousandths of an inch. Torque is achieved by making a force-inducing projection in the plastic with Hilliard Thermo-pliers or composite mounding on the labial and lingual aspect of the target tooth at the same time. Also, a block-out material is placed by the clinician on the cast to allow tooth movement [30].

TORQUE EXPRESSION OF SELF-LIGATING BRACKETS

In general, based on the manner of slot closure, self-ligating brackets fall into one of two design categories, namely; active and passive (Figure 12). Badawi and coworkers studied the difference in third-order moments that can be delivered by engaging 0.019 x 0.025-in stainless steel archwires to 2 active self-ligating brackets and 2 passive self-ligating brackets. They concluded that as the active clip forces the wire into the bracket slot, the active self-ligating brackets have better torque control. The amount of archwire bracket slop was comparatively less in active self-ligating brackets. The passive self-ligating brackets produced lower moments at low torsion angles and produced higher moments at high torsion that cannot be used clinically. Compared to passive self-ligating brackets, the active self-ligating brackets have greater clinically applicable range of torque activation, higher expression of torque at clinically usable torsion angles (0°-35°) [31]. Thomali et al evaluated the torque expression in active and passive selfligating brackets and concluded that there was minor difference in the torque expression of the two brackets. The torque expression increased with increase in engagement angle and also with an increase in slot size [32].

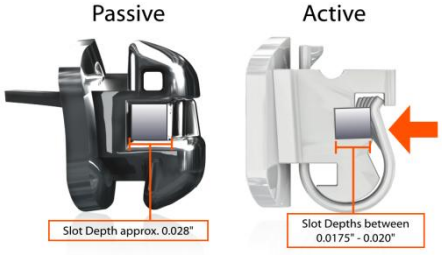


Figure 12: Passive and Active self-ligating brackets

VARIATIONS IN TORQUE EXPRESSION

Despite the abundance of empirical and research data on the necessity of adequate torque, there is a striking variability among various prescriptions with respect to anterior dentition torque values. Thus, the maxillary central incisor torque in pre-adjusted appliances ranges from 12° in the Roth prescription to 22° in the Bio-progressive prescription, a variation reaching almost 100% of the suggested value. Torque variation generally occurs due to the following sources; manufacturing processes, material properties and biologic variables [33]. Morina compared the conventional brackets with the self-ligating brackets for their ability to generate the moment angle able to produce the torque [34]. The torque maintenance was found to be the best for the ceramic brackets, followed by conventional metal brackets, then self-ligating active brackets and self-ligating passive brackets [35, 36].

CONCLUSION

Torque can influence the outcome and stability of the orthodontic treatment in ways more than one. Great care is needed with respect to torque control while treating cases with any treatment philosophies and appliance systems that are currently available. Torque control should be maintained from the initial stages of the treatment, so that moving teeth to their finished positions begins soon after the placement of brackets and the first archwires. With torque, a gradual flow towards the finishing stage is achieved, with less work required towards the end. Future research and product development should be directed towards improvement of the current knowledge and armamentarium for this purpose so that the goals of orthodontic treatment viz. obtaining functional occlusion, esthetics, and stability are attained at their very best.

REFERENCES

1. Thicket E, Taylor NG, Hodge T. Choosing a pre-adjusted orthodontic appliance prescription for anterior teeth. J Orthod. 2007;34:95-100.
2. Germane N, Bentley BE, Isaacson RJ. Three biologic variables modifying faciolingual tooth angulation by straight-wire appliances. Am J Orthod Dentofacial Orthop. 1989;96:312-9.
3. Rauch ED. Torque and its application to orthodontics. Am J Orthod. 1959;45:817-30.
4. Holdaway R A. Changes in Relationship of Points A and B. Am J Orthod. 1956;42:176-93.
5. Zachrisson BU. Making the premolar extraction smile full and radiant. World J Orthod. 2002;3:260-5.
6. Ketcham AH. A preliminary report of an investigation of apical root resorption of permanent teeth. Int J Orthod. 1927;13:97–127.
7. Beck BW, Harris EF. Apical root resorption in orthodontically treated subjects: analysis of edgewise and light wire mechanics. Am J Orthod Dentofacial Orthop. 1994;105:350-61.
8. Adams CP. The design, construction and use of removable orthodontic appliances. 5th ed. Bristol, NU: John Wright and Sons Ltd; 1984. p82.
9. Thurow RC. Edgewise Orthodontics. 4th ed. St Louis, Mo: CV Mosby Co; 1982. p39.
10. Isaacson RJ, Lindauer SJ, Rubenstein LK. Moments with the edgewise appliance: Incisor torque control. Am J Orthod Dentofacial Orthop. 1993;103:428-38.
11. Bernstein L. Root torque with Warren springs. J Clin Orthod. 1971;5(3):167-9.
12. Nanda RS. Biomechanics and Esthetic Strategies in Clinical Orthodontics. St Louis, Mo: Elsevier Saunders; 2005. p120.
13. Graber TM, Swain BF. Orthodontics: current principles and techniques. St Louis: CV Mosby; 1985. p717.
14. Swain BF. Begg differential light forces technique, in Graber TM Current orthodontic - concepts and techniques, Philadelphia, TV. B. Saunders Company; 1969. p665.
15. Begg PR, Kesling PC. Begg orthodontic theory and technique, 3rd ed. Philadelphia, W. B. Saunders Company; 1977. p132.
16. Kitchton JF. The Kitchton Torquing Auxiliary. J Clin Orthod. 1967;10(1):72-3.
17. Tan F. Begg Reverse Torquing Auxiliary. J Clin Orthod. 1987;11(21):789-90.
18. Mollenhauer B. An aligning auxiliary for ribbon arch brackets: rectangular boxes from ultrafine high tensile wires. Aust Orthod J. 1990;11:219-26.
19. Graber LW, ed. Orthodontics, State of the art, Essence of the science. St Louis: CV Mosby; 1986. p167.
20. Roth R. The straight-wire appliance 17 years later. J Clin Orthod. 1987;21(9):632–42.
21. Alexander RG. The Vari-Simplex Discipline Part 1 Concept and Appliance Design. J Clin Orthod. 1983;17(6):380-92.
22. Hilgers JJ. Bio-progressive Simplified Part 2 The Linear Dynamic System. J Clin Orthod. 1987;21(10):716-34.
23. McLaughlin RP, Bennett JC, Trevisi HJ. Systemized Orthodontic Treatment Mechanics. St Louis, Mo: CV Mosby Co; 2001. p8.
24. Owen A H. Torque in the Base vs. Torque in the Face. J Clin Orthod. 1991;25(10):608-10.
25. Cannon JL. Dual Flex Archwires. J Clin Orthod. 1984;9(18):648-9.
26. Scuzzo G, Takemoto K. Invisible Orthodontics– Current concepts and solutions in lingual Orthodontics. Quintessenz Verlags-GmbH. 2003;9-10.
27. Hong RK, Sohn HW. Update on the Fujita lingual brackets. J Clin Orthod.1999;33:136-42.
28. Paige SF. A Lingual Light-Wire Technique. J Clin Orthod. 1982;16(8):534-44.
29. Graber TM, Vanarsdall RL, Vig KWL, eds. Orthodontics: Current Principles and Techniques. 4th ed. St Louis, Mo: Elsevier Mosby; 2005. p145.
30. Anbuselvan GJ Senthil kumar KP, Tamilzharasi S, et al. Essix Appliance Revisited. NJIRM. 2012;3(1):125-38.
31. Badawi HM Toogood RW, Carey JPR et al. Torque expression of self-ligating brackets. Am J Orthod Dentofacial Orthop. 2008;133:721-8.

32. Thomali YA Mohamed RN, Basha S. Torque expression in self-ligating orthodontic brackets and conventionally ligated brackets: A systematic review. J Clin Exp Dent. 2017; 9(1):e123–8.
33. Gioka C, Eliades T. Materials-induced variation in the torque expression of pre-adjusted appliances. Am J Orthod Dentofacial Orthop. 2004;125:323-8.
34. Morina E, Eliades T, Pandis N, et al. Torque expression of self-ligating brackets with conventional metallic, ceramic and plastic brackets. Europ J Orthod. 2008;30:233–8.
35. Broadbent JM. Patient-specific treatment with variable torque straightwire. Funct Orthod. 2003;20:4-30.
36. Harzer W, Burauel C, Gmyrek H. Torque capacity of metal and polycarbonate brackets with and without metal slot. Europ J Orthod. 2004;26:435–41.

How to cite this article: Deepshikha, Chaukse A, Gupta K. Torque in Orthodontics. J Orofac Res. 2020;9(3):32-38.

Funding: None; Conflict of Interest: None Stated.