Torque in operative dentistry

Authors: Dr. Prashanth Kumar Katta MDS[1], Dr. Meghraj D[2], Dr. Sheela .N.V[3] Dr. Dharmesh.H.S[4]

Abstract:

the motor whether it is endomotor or the handpiece used to cut the tooth should have sufficient torque so that the endodontic file does not fracture inside the canal or the bur doesn't wear out and there is no damage to the bearings of the handpiece. Adequate torque is very essential for cutting of the dentin within the root canal. Sufficient torque ensures smoother functioning of the device.

Keywords: Torque, speed, ratios, advantages of torque control

Introduction:

What is torque?

It is total of moments acting on a particle. It acts in a rotational manner. It's the ability of the handpiece to withstand lateral pressure on a revolving tool with decreasing its speed or cutting efficiency. It is the force developed during rotation.

Torque is a measure of how much force is acting on an object which allows it to rotate. Torque also called moment ox moment of force is a tendency of force to rotate an object on axis, fulcrum, or pivot, just as a force is a push or a pull, a torque can be thought of as a twist. In simple terms, torque is a measure of the turning force on an object such as a bolt oz a fly wheel, for example, pushing oz pulling the handle of a wrench connected to a nut or bolt produces a torque (turning force) that loosens or tightens the nut or bolt[1].

It is dependent on:

1. Type of bearing used
2. Amount of energy supplied to the handpiece
3. It governs the instrument locking, deformation and separation

Theoretically instruments used on high torque the incidence of these three variables is high and when used on low torque the cutting efficiency is less and advancing the instrument in the canal will be difficult[2]. Instruments using wide range of torque are also available.

Torque is expressed in watts (W) and is an indication of the handpieces' cutting power. Torque is more applicable to how efficient the handpiece will be then speed. With regard to air driven handpieces, the larger the handpiece head, the larger the turbine within the head. The larger the turbine the more torque can be delivered. Depending on the size of the head, air-driven handpieces will provide between 12W and 18W of cutting power. These handpieces are offered in mini-head, standard head, and high-torque heads. A mini-head will offer almost 14W and is ideal for pedodontic restorations, endodontic access, and treatment of second or third molars because of the restricted clearance and composite/amalgam restorations. Standard heads provide more power (15W to 17W) but need greater clearance and obscure more of the field then a mini-head. These are good overall handpieces suited for crown and bridge preparation and most treatments provided in an average practice. For more demanding tasks such as removing non-precious crowns or heavy amounts of crown and bridge, a high torque head may be better suited for those tasks. These will offer almost 18W but have larger heads then a standard head on an air driven handpiece.

1. **Dr. Prashanth Kumar Katta MDS**
   Reader
   Department of Conservative Dentistry & Endodontics
   Bapuji Dental College & Hospital
   Davangere-577004
   Mob: 9449764882 Email:drprashanthkumar@yahoo.com
2. **Dr. Meghraj D**
   Department of Prosthodontics,
   Faculty of Medical Technology, Libya
3. **Dr. Sheela NV**
   Senior Lecturer, Department of Endodontics & Conservative Dentistry
   RV Dental College, Bangalore
4. **Dr. Dharmesh.H.S**
   Senior Lecturer
   Department of Orthodontics
   Raja Rajeswari Dental College & Hospital, Bangalore

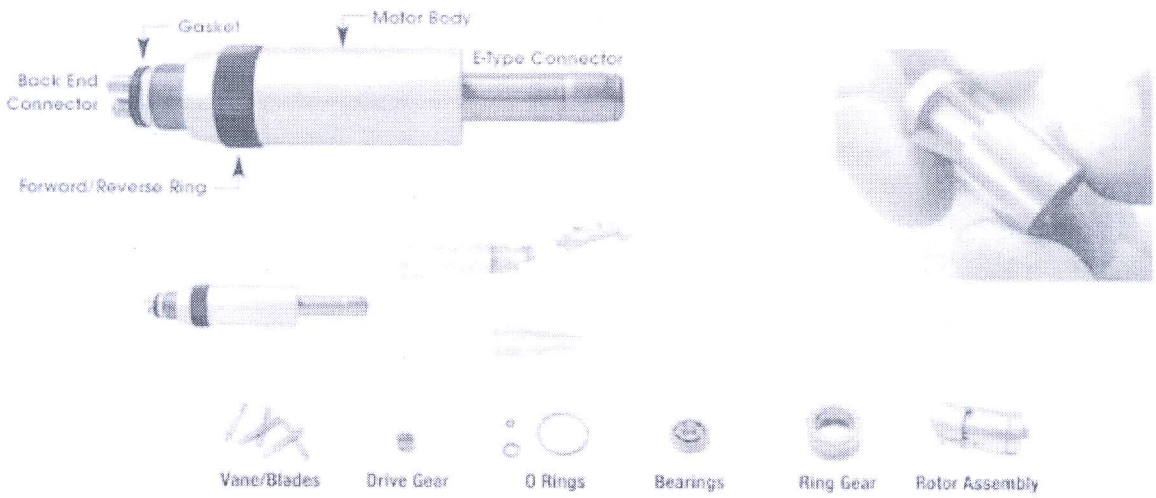

Figure 1: Handpiece and the internal bearings

Difference between speed and torque[3]

SPEED	TORQUE
Speed is expressed in revolutions per minute (rpm)	Torque is expressed in watts and is an indication of the **tool's cutting power.** **The efficiency of the handiece depends more on torque than speed.**

Air-driven high-speed handpieces typically will have speeds between 250,000 and 420,000 rpm but the torque is relatively low. The speed decreases with increase in pressure during cutting because the air in the compressor can't withstand the pressure.

The torque of air driven handpiece depends on size of the head.

These handpieces are offered in

1. Mini-head: 14W
2. Standard head: 15-17W
3. High-torquehead: 18W

An electric handpiece may have speeds around 200,000 rpm but relatively high torque. In these the speed and torque are constant regardless of the pressure during cutting. Power output with electric handpieces is greater than with air-driven handpieces, offering 33 to 45 watts of cutting power.

The most interesting advancement is constant torque. The electric handpiece has a fully adjustable bur speed, which can be adjusted with a dial or the foot control. The highest bur speed is 200,000 rpm. At this speed, the electric handpiece produces 60 W of cutting power, while an air-driven handpiece running at top speed produces less than 20 W. This simply means that the electric delivers constant torque. The bur will not stop or slow down, no matter what material you are cutting, through all the speed ranges. The electric will still cut tooth structure at 5,000 rpm.

Power output is not dependent on head size.

Power and speed: Power, the ability of a handpiece to remove tooth structure, is a function of torque and turbine speed[11].

Cutting efficiency is actually a balance between the speed and torque delivered to the bur.

As load (torque) increases, speed decreases and will cause the handpiece to stall at some point.

The slope of the curve, or rate of decrease in speed with increasing torque (load), and the height of the curve at a particular torque (e.g. 0.7 mNm) is related to the percentage decrease in cutting speed (Table 3) resulting from the application of a constant load (150 g) for each handpiece.

Difference between power and torque[4,1]

Power is measured in Watts

So for the application of cutting a tooth with a highspeed handpiece, the power of the handpiece would determine how long it would take to remove a predetermined amount of tooth material.

Torque – for handpieces would translate into "stall torque" – is measured in N-cm.

So for the application of cutting tooth with a highspeed handpiece, the torque of the handpiece would determine how much pressure could be applied to the bur before the handpiece stalled during cutting.

To generate cutting power:

A high speed handpiece needs both rotational speed (rpm) and torque. The product of the two (speed x torque) determines its power and how fast tooth material is removed.

Torque in dentistry; root canal therapy

In many aspect of practice in dentistry, especially in root canal therapy for root canal preparation, there is a turning force on an instrument. Torque is a parameter that must be controllable in root canal preparation, because of different instruments which have been used, seem to need different values of torque. In root canal preparation, safety usage of instrument depends on considering the torque at failure of instrument. The instruments are subjected to different of torsional torque, if the level of torque is equal to or greater than the torque at failure (fracture), the instrument will separate.

Torque control hand pieces[5,2]

Different types of hand pieces are used in conjunction with the rotary instruments, the air and electric motors without torque control and the electric torque control motors.

Theoretically, the torque control hand pieces (motors) take into consideration the torque at failure of rotary instrument.

Torque values lower than the torque at fracture of the instruments can be set on the torque control hand pieces.

When a high torque control hand pieces is used the instrument is very active and the incidence of instrument locking and, consequently, deformations and separation would tend to increase.

Air driven hand pieces or air motors do not allow torque control and variation in air pressure could affect the rotational speed and, consequently, torque. For instance a drop in air pressure would lead to a decrease of torque.

The instrument would become less active, and the operator would tend to force the instrument in to the canal of teeth leading to deformation and separation.

Recently a generation of low and very low torque control motors has been introduced; torque values as low as 1N/ can be set on these torque control motors, respectively, these motors take into consideration and low torque at failure values of rotary instruments.

If the high-torque is used the instrument specific torque limit is often exceeded, thus increasing the mechanical stress and the risk of fractures, it must be emphasized that the elastic limit of the tested instrument was found to be lower than 1N/ when subjected to torsional testing. To limit this potential breakage, a low torque motor should be used , if the torque is set just below the limit of elasticity for each instrument, the mechanical stress is lower, the risk of deformation and separation is likely to be reduced to an extent far below what has been possible before.

With the low torque motor, the motor will stop from rotating and can even reverse the direction of rotate when the instrument is subjected to torque level equal to the torque value set on the motor thus instrument failure would be avoided.

Advantages and disadvantages of new torque-controlled endodontic motors and low-torque NiTi rotary instrumentation[6]

Advantages:

- reduced pressure/force required
- computer-controlled electronics

- allows for fine adjustment of torque values
- improved tactile and 'mental' awareness
- greater resistance to cyclic fatigue of rotary endodontic instruments
- reduces rate of fracture of rotary files

Disadvantages:

- < cutting efficiency
- slower instrument advancement
- increases time of debridement procedure

The torque generated during instrumentation of small canals is higher than that in large canals. Also, as the file diameter increases; the torque (force) needed to begin unwinding or to fracture also increases. If the torque reaches a critical level, the instrument undergoes structural failure resulting in separation[7, 8]. When a high torque is used, the instrument is very active and the incidence of instrument locking and consequent deformation and separation tends to increase. Sometimes instruments become less active and the operator may force the instrument into the canal, leading to deformation and separation. With respect to root canal curvature, smaller files fail at less torque, as do files in more acutely curved canals. It has been reported that instruments used with low-torque motors (are more resistant to fracture than those used with high-torque motors (>3 N/cm). Therefore, practitioners should use electric motors set at low torque levels during root canal preparation.

Slow speed, low-torque (right-torque) motors

These are particularly indicated in curved canals where the resistance is more and the chances of file getting locked are more. The torque is set below the optimum torque value of instrument fracture. When the motor reaches this value while operating the instrument stops rotating momentarily and start rotating in reverse direction and thus fracture is avoided[9, 3].

Disadvantage: It should be mentioned that with the use of the low-torque motor the cutting efficiency was reduced. This modification was the greatest for the smallest rotary files, when compared to traditional endodontic motors. Although this might not be a major problem, it could be irritating at first in that excessive resistance is felt in the canal, so that instrument preparation to the apex was blocked. In these cases, the usual operative sequences had to be modified. Usually additional crown-down enlargement was necessary before the apex could be reached. Coronal enlargement always decreases the overall canal curvature, and consequently reduces the mechanical stress on the instruments in the apical area.

Understanding Gear Ratios for speed[10, 5]

Electric handpieces will have a gear ratio imprinted on the handpiece which helps identify what procedures are best performed with that particular gear ratio. The ratio is expressed as X:Y, with a high-speed handpiece having a 1:5 ratio, and those intended for slow-speed procedures having a ratio expressed as 1:1. Some companies also offer handpieces for "ultra" slow-speed procedures such as pin placement or endodontics with a gear ratio of 10:1 or 16:1.

Typical procedures done with a high-speed (1:5) handpiece would be cavity preparation, crown preparation, and sectioning existing fixed prosthetics. These high-speed handpieces accept standard friction-grip burs or diamonds and push-button bur chucks. Slow-speed (1:1) handpieces would be indicated for caries removal, preparation refinement, and adjustment of ceramics.

Typical speed-reducing attachments offer ratios ranging from 8:1 (the bur spins at 1/8 motor speed) to 27:1 (1/27th of the motor speed); other ratios are also available. The gears in these speed-reducing attachments slow the instruments down for very low-speed procedures, including rotary endodontics. With the proper controller features, an electric handpiece system can double as a rotary endodontic system.

Conclusion Torque control motors are boon to endodontists as it has significantly reduced the incidence of instrument separation significantly. The digitally torque controlled motors should be used optimally and the dentist must ensure better results. Electrical handpieces with static torque despite increase in pressure helps in better cutting of the tooth/bone but the operator should be careful as it can burn the tissue.

Conflict of interest: None

Source of funding: Self

Acknowledgements: None

Ethical clearance: Not applicable

References

1. Rationale for the use of low-torque endodontic motors in root canal instrumentation, Gambarini G., Endod Dent Traumatol 2000; 16: 95–100
2. Advantages And Disadvantages Of New Torque-Controlled Endodontic Motors and Low-Torque NiTi Rotary Instrumentation, Gambarini G., Australian Endodontic Journal, Volume 27,HYPERLINK "http://onlinelibrary.wiley.com/doi/10.1111/aej.2001.27.issue-3/issuetoc" HYPERLINK "http://onlinelibrary.wiley.com/doi/10.1111/aej.2001.27.issue-3/issuetoc"Issue 3, HYPERLINK "http://onlinelibrary.wiley.com/doi/10.1111/aej.2001.27.issue-3/issuetoc"pages 99–104, December 2001
3. Factors contributing to the separation of endodontic ?les , A. A. Madarati, D. C. Watts and A. J. E. Qualtrough, British Dental Journal Volume 204 no. 5 mar 8 2008
4. Revolutions in endodontic instruments-a review, Revathi M; Rao CVN; Lakshminarayanan L, Endodontology. 2001 Dec; 13(2): 43-50
5. Electric Handpieces: An Overview of Current Technology, Gregori M. Kurtzman, Inside Dentistry, February 2007, Volume 3, Issue 2
6. Rethinking the Dental Handpiece, David Little, DDS, November/December 2010, Volume 31, Issue 9
7. Electric handpiece systems, ADA Professional Product Review vol. 2 | issue 1
8. A Review of Electric Handpieces, dental economics
9. Intelligent Torque Control Motors in Dentistry, Mohammad Hassan Zarrabi and Maryam Javidi, www.intechopen.com

The Causes, Prevention, and Clinical Management of Broken Endodontic Rotary Files

10. , dentistry today, 01 November 2005
11. Performance of high-speed dental handpieces subjected to simulated clinical use and sterilization Daniel I. Leonard, D.D.S.; David g. Charlton, D.D.S., M.S.D., JADA, Vol. 130, September 1999

Corresponding author:
Dr. Prashanth Kumar Katta MDS
Reader
Department Of Conservative Dentistry and Endodontics
Bapuji Dental College & Hospital
Davangere-577004
Mob: 9449764882
Email:drprashanthkumar@yahoo.com