Cleaning and shaping the root canal system – Mechanical instrumentation

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Outline:

i- Mechanical instrumentation:
   a- Definitions
   b- The chemo-mechanical instrumentation concept.
   c- Hand instrumentation:
      1- instrumentation motions:
         Reaming, filing, watch winding, balanced force, anti-curvature filing
      2- Techniques:
         The step-back technique
         The crown-down technique
         Hybrid techniques
   d- Rotary instrumentation
   e- The smear layer
   f- Procedural errors during canal instrumentation
Root canal treatment

- Chemo-mechanical disinfection
  - Mechanical instrumentation
  - Irrigation with chemicals
- Fluid-tight seal
  - Root canal obturation
  - Coronal seal
- Inter-appointment medicament
Root canal debridement:

The elimination of infection from within the root canal system by removing the vital and necrotic tissues along with infected root dentine. Mechanical instrumentation of the root canal aims to remove the bulk of infection from within the root canal system. However, it cannot sufficiently reduce the bacterial “load” to levels compatible with healing. Additional chemical disinfection measures are required, which include irrigation and inter-appointment medication.
Objectives of mechanical instrumentation:

1- Eliminate microorganisms from the root canal system

2- Remove pulp remnants and organic debris which provide a substrate for microbes.

3- Remove the superficial infected layer of radicular dentine.

4- Shape the canal in a way to facilitate the access of irrigating solutions and medicaments and the placement of a well compacted root canal filling.
The ideal canal preparation:

i. The canal must remain in its original position.

ii. The apical foramen must remain at its original location and size.

iii. The canal must resemble a tapered funnel and be kept as small as is practical.

iv. The preparation should resemble a tapering funnel
Objectives of chemical disinfection:

1- To flush out remnants of pulp tissue and debris created during mechanical instrumentation.

2- To dissolve residual pulp tissue

3- To kill microbes and remove microbial biofilm

4- To clean the parts of the root canal that are inaccessible to mechanical instrumentation (eg: isthmi, lateral canals.. Etc)

5- Facilitate instrumentation by acting as a lubricant

6- To remove the smear layer
Taper:

A gradual decrease in canal diameter in a corono-apical direction

\[ \text{Taper} = 0.45 - 0.4 = 0.05 \text{ (i.e.: } 5\%) \]
Why do we need a tapered canal preparation?

1- To facilitate the flow of irrigants in the canal

2- To reduce the stress on the instrument during instrumentation

3- To facilitate obturation and the placement of inter-appointment medication.
Hand instruments:

K-files:

- Colour-coded according to their tip diameter
- Come in different lengths: 21, 25 and 31mm
- Standardized 0.02 taper

Cross section
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<th>Tip diameter</th>
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Gates Glidden drills:

- Stainless steel drills with long shanks
- Non-cutting tip (side cutting action)
- Used for coronal flaring
- Sizes 1-6: respective bands on each drill
- Sizes: 1: 0.5mm (50 k-file)
  2: 0.7mm (70 k-file)
  3: 0.9mm (90 k-file)
  4: 1.1mm (110 k-file)
  5: 1.3mm (130 k-file)
  6: 1.5mm (150 k-file)
Mechanical steps of root canal treatment:

1. Access cavity preparation
2. Working length determination
3. Canal instrumentation (cleaning and shaping)
4. Obturation of the prepared root canals
5. Provision of coronal seal.
Basic instrumentation motions:

a- Filing motion:

A linear motion with push and pull action with effective action during pulling. It aims to scrape the canal wall. Also known as rasping motion. The most effective cutting motion especially with H-files. Can pack debris apically which can block the canal or be pushed out of the apex.
Basic instrumentation motions:

b- Reaming motion:

A clockwise, cutting rotation of the file.

Instrument is inserted into the canal until binding is encountered. It is then rotated clockwise 180-360° and pulled out.
Basic instrumentation motions:

c- Watch winding motion:

A reciprocating back and forth (clockwise/counterclockwise) rotation of the instrument in the canal.

Light apical pressure is applied to move the file deeper into the canal.
d- Balanced force technique:

Allows controlled manipulation of hand files whilst maintaining a centered preparation and reducing the incidence of procedural errors.

The file is inserted in the canal until resistance is met and rotated 90° clockwise to engage dentine in its flutes.

The file is then rotated 180° counterclockwise whilst maintaining apical pressure. This action cuts dentine from the canal wall and is associated with a characteristic click. A further clockwise rotation collects debris on the flutes before being withdrawn from the canal.

![Diagram of file rotation](image)
e- Anti-curvature filing:

The controlled and directed preparation into the bulky or safety zones and away from the thinner portions or danger zones of the root structure where perforation or stripping of the canal walls can occur.

A concept described by Abou Rass in 1981.
Hand instrumentation techniques:

- Standardized technique
- Step-back technique
- Crown-down technique
- Hybrid techniques
The step-back technique:

Is a technique whereby the canal is prepared with sequentially increasing sizes of files in an apical to coronal direction.

Consists of the following phases:

i. Initial negotiation

ii. Coronal flaring

iii. Apical preparation phase

iv. Step back phase

v. Refining/finishing phase
i- Initial negotiation:

- A size 10 or 15 k-file is worked apically using a watch-winding motion to ensure that the coronal portion of the canal is negotiable.
- Not necessary to negotiate the canal to the apex at this stage
- Pulp chamber flooded with NAOCl to avoid blockages
- File should not be forced apically
ii- Coronal flaring phase:

- Start with GG size 2 to about ½ to ⅔ of the canal length.
- Use GG size 3 in the coronal ⅓ of the canal length.
- Use G.G. size 4 no more than 3mm below the orifice of the canal.
- (G.G. size 5 and 6 are used only to enlarge the orifice of canals in certain cases; e.g. long teeth or severely curved canals)
- When using Gates Glidden burs, do not force them into the canal to avoid perforation of the canal wall and/or instrument separation.
Coronal flaring

Size 2: junction between coronal and middle thirds

Size 3: size 2 – 2mm

Size 4: size 3 – 2mm
iii- Apical preparation phase:

1. Flood the cavity with irrigant
2. WL measurement
3. Apical gauging:
   Identification of initial binding (apical) file
   The first file that binds at the working length
   Gives information about the original size of the canal
4. Insert the IAF to WL with “watch-winding” and then with pull strokes work against the canal walls.

Circumferential Filing: A Filing technique where the file is worked against the root canal wall during its cutting action (pull stroke). This is done against all walls equally
iii- Apical preparation phase:

5. Irrigation with NaOCl between every 2 instruments.

6. Insert the next larger file to WL, with "watch-winding" and pull strokes (as in previous step), work against the canal walls until it fits loosely to WL.

7. Recapitulation

8. Repeat steps 6-8 until the desired file size = Master Apical File (MAF)
The master apical file:

MAF is the largest file used to WL in a completely prepared canal

MAF size is recommended to be usually three sizes wider than IAF, minimum ISO 30

Preparing canals to sizes smaller than ISO 30 does not create sufficient room for the irrigating solutions and medicaments.

However, this should be balanced with root canal anatomy and type of tooth/root.

*e.g. severe curvatures= 25, upper central incisor = 45 minimum.*
iv- The step-back phase:

1. Place a file one size larger than MAF into the canal 1mm short of the WL
2. Work against the walls until it is loose within the canal
3. Recapitulation to full length with MAF file to remove of dentine chips.
4. Copious irrigation before introducing next size instrument
5. Repeat Until reaching middle third
The step-back technique:
v- Refining phase:

Return to MAF, smoothing all around the walls with vertical push-pull strokes.

Placing the file into the canal and pressing it laterally while withdrawing it along the path of insertion to scrape (plane) the wall.
**Recapitulation:**

The introduction of smaller files to full WL during root canal preparation to keep the apical area clean and patent. Helps prevent packing of dentinal debris and loosening these debris to be flushed out with irrigation. Helps in maintaining the WL and avoiding blockage.
Patency filing:

Refers to the passive placement of a small hand file (size 10 or smaller) 0.5-1mm through the apical constriction during root canal preparation.

The aim of patency filing is to prevent blockage of the apical portion of the root canal by debris created during instrumentation.

A potential drawback of patency filing is that infected debris might be extruded into the periapical tissues, resulting in post-operative flare-up.
The crown-down technique:

A pressure-less technique where the coronal third is first flared and then files (in descending order) are used to advance into the canal in small increments.

Advantage:

✓ Reduced apical debris extrusion
✓ Reduced stress on the files.
The crown-down technique:

0.08 Taper

0.06 Taper

0.04 Taper
Rotary instrumentation:

- Instrumentation of the canals using engine driven files made of Ni-Ti
- Superelastic alloy with shape memory
- Used with electric motor to control speed and torque
- Work mainly in a crown-down manner
The smear layer:

Root canal instrumentation produces a layer of organic and inorganic material known as the smear layer.

Composed of dentin particles, organic debris, odontoblast processes, microorganisms and their metabolic products.

It can prevent the penetration of irrigants and intra-canal medicaments into dentinal tubules therefore compromising disinfection.

Can influence the adaptation of the root filling materials to canal walls (prevents the penetration of sealers) therefore compromising the sealing ability of obturation.

Can serve as a substrate and nutrition source for residual bacterial.

Should be removed before the canals can be obturated (although clinical significance is controversial).
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The organic part is removed via irrigation with NaOCl, while the inorganic part is removed by irrigation with EDTA or citric acid.
Instrumentation-related errors:

1- Ledge

II- Zip and transportation

III- Perforation

IV- Strip perforation
Any Questions?
<table>
<thead>
<tr>
<th>Canal scouting</th>
<th>Apical preparation</th>
<th>Step back</th>
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![Image of canal scouting, apical preparation, and step back tools](image-url)