HISTORY
Bunon (1743): First person to propose that removal of deciduous teeth will achieve a better alignment of permanent teeth, in his book “Essay on diseases of teeth”.
Kjellgren (1929): First person to suggest the term “serial extraction” for this procedure.
Nance (1940): Father of serial extraction philosophy. He presented the technique of progressive extraction.
Palsson (1956): Proposed that extraction can be done to improve irregular alignment and crowding of teeth.

DEFINITION
Serial extraction or Guidance of eruption is defined as a well-planned sequence of tooth removal during the transition from the primary to the permanent dentition involving timed extractions of primary, and ultimately, permanent teeth, for the purpose of

⇒ relieving crowding and irregularity of teeth
⇒ allowing unerupted teeth to guide themselves into improved positions
⇒ as an adjunct to comprehensive orthodontic therapy

Note: Serial extraction by itself does not result in an ideal tooth position or closure of excess space.

RATIONALE
Serial extraction is a positive interceptive orthodontic procedure generally applied where supporting bone is less than the total tooth material.
Extraction of primary canines eliminates crowding of permanent incisors.
Extraction of 1st premolars before the eruption of permanent canines and 2nd premolars results in distal eruption of canines and may bring about spontaneous closure of spaces. The average width of 1st premolar is 7-8 mm; Extraction of premolars creates 14-16 mm of space in the arch. After serial extraction incisors tend to drift lingually and the posterior teeth tend to drift mesially to some extent, leading to 2-3 mm of space closure in each quadrant, or a total of 4-6 mm. Thus the remaining 10 mm is available for resolution of crowding.

Please refer notes on “Incisal Liability” for better perception of the need for serial extraction.

IDEAL CONDITIONS FOR SERIAL EXTRACTION
1. A true relatively severe hereditary tooth-size jaw-size discrepancy (perimeter arch deficiency).
2. A mesial step mixed dentition developing into a Class I permanent relationship.
3. A minimal overjet relationship of incisor teeth.
4. A minimal overbite relationship of incisor teeth.
5. An orthognathic facial pattern, or a face with a slight alveolodental protrusion (Class I maxillary mandibular alveolodental protrusion).
6. Class II maxillary alveolodental protrusion (serial extraction only in the maxillary arch).
7. No skeletal disproportions.
8. No aberrant muscle activity.

Note: True hereditary tooth-size jaw-size discrepancy resulting in crowding of dental arches usually requires extractions, whereas environmental crowding can be treated without extractions.
SIGNS OF TRUE HEREDITARY TOOTH-SIZE JAW-SIZE DISCREPANCY

1. Maxillary mandibular *alveolo-dental protrusion* without interproximal spacing.
2. *Crowded* mandibular incisor teeth.
3. A midline displacement of the mandibular permanent incisors, resulting in the *premature exfoliation* of the *primary canines* on the crowded side.
4. A midline displacement of the mandibular permanent incisors with *lateral incisors* on the crowded side *blocked out*, usually lingually, but occasionally labially.
5. A *crescent area of external resorption* on the mesial aspects of the roots of the *primary canines* caused by crowded permanent lateral incisors.
6. Bilateral primary mandibular canine exfoliation resulting in an uprighting of the permanent mandibular incisors; this, in turn, *increases the overjet and/or overbite*.
7. A *splaying out of the permanent maxillary or mandibular incisor teeth* caused by the crowded position of the unerupted canine.
8. *Gingival recession* on the labial aspect of the prominent mandibular incisors.
9. A prominent *bulging in the maxilla or mandible* caused by the crowding of the canines in unerupted position.
10. A discrepancy in the size of the primary and permanent teeth, *reducing the leeway space*.
11. Ectopic eruption of the permanent maxillary first molars, resulting in the *premature exfoliation* of primary maxillary second molars. *This indicates a lack of development of the tuberosity area*.
12. A *vertical palisading of the maxillary permanent molars* in the tuberosity area, again indicating a lack of jaw development.
14. Eruption of canines mesial to the lateral incisors.
15. Mesial drift of the buccal segment.

SIGNS OF ENVIRONMENTAL CROWDING

1. Trauma.
2. Iatrogenic dental treatment.
3. A discrepancy in the size of individual teeth.
4. A discrepancy between maxillary tooth size and mandibular tooth size.
5. An aberration in shape of teeth.
6. An aberration in eruptive pattern of permanent teeth.
7. Transposition of teeth.
8. Uneven resorption of primary teeth.
9. Rotation of teeth.
10. Suppression of primary teeth.
11. Decrease in arch length caused by interproximal caries in primary teeth.
12. Altered emergence sequence of permanent teeth.
13. Altered exfoliation sequence of primary teeth.
14. Prolonged retention of primary teeth.

CONTRAINDICATIONS OF SERIAL EXTRACTION

1. Severe Class II and Class III dental malocclusions.
2. Skeletal malocclusions.
3. Congenitally absent/missing 2nd premolars.
4. Extensive caries of permanent 1st molars.
5. Cleft lip and Cleft palate cases.
6. Unilateral congenital absence of teeth.
SERIAL EXTRACTION

7. Abnormal tooth size, shape, colour etc.
8. Presence of deepbite, openbite, crossbite, rotations, and gross malpositions of teeth.
9. If arch length deficiency is less than 4 mm. (If it is between 5-9 mm, some residual space may be expected after serial extraction; If it is $\geq 10$ mm, there is no residual space usually).
10. Missing 3rd molars. (Arch length may be gained on the posterior end of the alveolar trough).

PROCEDURAL DIAGNOSTIC STEPS FOR SERIAL EXTRACTION

1. Clinical examination: Examination of the profile.
2. Intraoral Periapical Radiographs
3. Cephalograms
4. Study model analysis
5. Photographs
6. Periodic radiographs to visualize dentition every 6 months

STAGES IN SERIAL EXTRACTION

1. **Extraction of primary lateral incisors** as permanent central incisors erupt, if necessary. Most often this occurs spontaneously.
2. **Extraction of primary canines** as permanent laterals erupt.
   - Done at 8 to 9 yrs of age.
   - Performed to allow eruption and alignment of permanent incisors.
   - This procedure may result in lingual tipping of lower incisors and an $\uparrow$ in overbite. But this does not pose a problem because labio-lingual displacements are better resolved than rotational displacements.
3. **Extraction of primary 1st molars** 6 to 12 months before their normal exfoliation time.
   - This is done to influence 1st premolars to erupt ahead of permanent canines, so that they can be extracted and permit canines to move distally into the space.
   - Done when there is half or two-third root formation of the 1st premolar.
   - Done usually between 9 to 10 yrs of age.
   - If mandibular canine is erupting before mandibular 1st premolar (which is usually the case):
     - mandibular deciduous 1st molars are extracted and premolars surgically enucleated at the same time, or
     - mandibular deciduous 1st molars are extracted first, and 6 months later deciduous 2nd molars are extracted. Unerupted premolars move distally into the alveolar bone as the canine erupts. When 1st premolar erupts, it is extracted. A lingual arch wire may be provided to prevent permanent 1st molar from migrating mesially.
4. **Extraction of 1st premolars**, just as canines emerge through the mucosa. One should check that:
   - All other teeth are present and sound
   - Permanent canines are mesially inclined

ALTERNATIVE METHODS OF SERIAL EXTRACTION

1. **Tweed’s method**
   Extraction sequence: D $\rightarrow$ 4 $\rightarrow$ C
   At 8 yrs, all deciduous 1st molars are removed.
- For early eruption of 1st premolar
- Deciduous canine is maintained to retard the eruption of permanent canine

After 4 to 10 months if crowns of 1st premolars are through the alveolar bone, they are extracted along with deciduous canines.
- To relieve crowding in the anterior region
- To allow the canine to erupt posteriorly into the space left by deciduous 1st molars.

2. Dewey’s method

Extraction sequence: C → D → 4
Deciduous canines are extracted first at the age of 8-9yrs.
- To allow incisors to align properly
- To guide eruption of lateral incisors
- To provide space for lateral incisors

Later deciduous 1st molars are extracted at the age of 10-11 yrs.
- To permit early eruption of 1st premolar

Finally 1st premolars are removed when they erupt.
- To relieve crowding in the anterior region
- To provide space for permanent canine

3. Nance’s method

Extraction sequence: D → 4 → C

4. Moyer’s method

Extraction sequence: B → C → D → 4; Indicated for crowding in the central incisor region and early eruption of permanent lateral incisor.

5. Others

C + D → 4.
C → D + enucleation of 4.
C → D → E → 4.
C → D. No permanent teeth are extracted.
D → C+4.

Extraction of some or all of the 2nd premolars instead of 1st premolars:
- If there is an openbite tendency, 2nd premolars of the mandible can be extracted
- If there is extensive caries of 2nd premolar(s) and relatively unaffected 1st premolar(s)

1st premolars can be retained if 2nd premolars are congenitally absent.

ADVANTAGES OF SERIAL EXTRACTION

1. Unerupted/erupted can be guided into proper occlusion.
2. Avoids loss of alveolar bone.
3. Reduces severity of malocclusion.
4. Reduces the duration of mechanotherapy.
5. Reduces the treatment time.
6. No TMJ problems.
7. No pain.
8. Less discomfort.
9. Retention is usually not needed because teeth are guided by muscular forces.
10. Cost of treatment reduced.
SERIAL EXTRACTION

DISADVANTAGES OF SERIAL EXTRACTION

1. Long-term procedure. Requires thorough knowledge of growth, development, eruption sequence and calcification of permanent teeth.
2. Psychological trauma to the child because of extractions.
3. If extractions are carried out too early:
   - Space loss
   - Delayed eruption of permanent successors
   - Elimination of an opportunity to extract teeth which may become doubtful (like permanent 1st molars)
4. The lower permanent canines may erupt ahead of 1st premolar into the space left by deciduous 1st molar causing impaction of 1st premolar, making the latter’s removal difficult.
5. Serial extraction may not preclude appliance therapy.
6. Tendency to deepen the bite because of lingual tipping of incisors.
7. Abnormal tongue thrusting into the extraction space may develop.
8. May interfere with growth and development because masticatory forces are not transmitted properly.

COMPLICATIONS OF SERIAL EXTRACTION

1. Removal of 1st premolar in the mandible causes tipping of the crowns and accentuation of “V” or “ditch”.
2. Bite tends to close, at least temporarily, during extraction supervision period. This is due to lingual inclination of mandibular incisors. ↓ in overbite occurs with eruption of 2nd and 3rd molars and associated growth increments of the mandible.
3. ↓ in arch length due to lingual tipping of mandibular incisors and ↑ in overbite.
4. Occasionally there may be forward rotation of maxillary permanent 1st molars.
5. Sometimes removal of 1st premolars may not stimulate distal migration of canines.
6. Eruption sequence may not be according to the normal schedule. Eruption in one quadrant may precede eruption in another quadrant.
7. If primary 1st molar is extracted early, the 1st premolar may not erupt before canine. This can lead to impaction of 1st premolar.
8. If enucleation of 1st premolar is done during serial extraction, it may leave a bone defect that may persist (An erupting premolar brings alveolar bone with it. Hence enucleation of unerupted premolar should be avoided as far as possible).
9. 1st premolar removal may enhance the forward tipping and impaction of mandibular 3rd molars.

APPLIANCES USED WITH SERIAL EXTRACTION PROCEDURE

1. Fixed or removable lingual arches to minimize mesial migration of permanent 1st molars.
2. Maxillary transpalatal holding arch (Nance arch), for the same reason as above.
3. Cervical headgear attached to anterior teeth to achieve Class I buccal interdigitation.
4. Removable Hawley appliance
   - To ↓ overjet.
   - To align rotated incisors.
   - With bite plane to correct deep overbites.
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