Serial Extraction

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INTRODUCTION

Heath has said, "Malocclusion of the teeth frequently constitutes an indignity with profound mental and physical stigma on our child patients. Their welfare is our challenging obligation."[1]

Without a perfect answer to many of our present orthodontic problems, we must utilize the solutions that have the least disadvantages. Serial extraction is not by any means a perfect answer, but just one of the many useful techniques in orthodontics. Serial extraction is designed to anticipate and minimize the development of a fully matured deformity in the permanent dentition, and it is accomplished by the extraction of a succession of deciduous and permanent teeth. Before serial extraction should be considered, its philosophy, technique and rationalization must be understood.

SELECTION OF CASES

When the tendency toward crowding is diagnosed early in the mixed dentition, most often the choice lies between an attempt at expansion aiming at normal occlusion and a compromised treatment, which is either reduction of dental units in connection with simplified appliance treatment, or possibly reaching an acceptable compromise result through extraction alone. The extraction of teeth is not to be taken lightly, but moving teeth a long distance in extraction cases after all the teeth have erupted is often unnecessary.

Serial extraction diagnosis demands a fine sense of clinical judgment, backed by long and critical study of the possibilities as well as the limitations of growth and development.

The individual cannot be judged against a statistical yardstick that has been derived from a group. Viewed in this light, it is absurd to think that a diagnosis can be based on a single angle or even a combination of angles, figures or facts. The nature of the phenomena that yield the infinite variety we see in the human countenance is only beginning to be understood. Serial extraction procedures should be limited to those conditions that show so little promise of potential development that an early decision should be made on some form of compromise treatment. In the serial extraction technique we can no more expect complete success than we can expect one hundred per cent perfection in any technique of orthodontics and, with poor selection, the chances of failure can become greater. There is little question today among most orthodontists about extraction being necessary, at least, in a rare number of cases. The real problem is where to draw the line between extraction and nonextraction cases.

A growth problem is being handled by the orthodontist and, therefore, the earlier the age of dealing with that problem, the better will be the chances of good results with a minimum of active treatment. It must be remembered that growth may not occur according to any statistical average, but any decision *except* the extraction of permanent teeth is not final. The ideal time to start the serial extraction procedure, except for borderline cases, is when the first permanent anterior tooth erupts. The size of all the teeth, es-

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pecially the anteriors, can then be approximated and crowding can be reasonably predicted since horizontal growth has been usually completed mesial to the first molars. The teeth then have the maximum time to align themselves with a minimum of rotations. Between the ages of six to eight years some appositional growth may occur mesial to the first molars which would be the difference in a marginal case, especially in large children.

If malalignment is acceptable with all its concomitant disadvantages (discomfort, premature bone resorption, reduced life of the dentition, higher caries rate, traumatic occlusion and periodontal disease), then serial extraction is not desired. The elimination of dental units is advisable in those cases where there exists an imbalance between the amount of tooth substance present and the amount of basal bone available. The muscular balance at the end of treatment is as necessary as that present in the original malocclusion for a stabilized denture. This can usually only be done by avoiding most expansion of the mandibular denture, particularly in the canine and molar areas, where muscular pressures are felt to a maximum degree. Any forward movement of the incisor teeth is contraindicated because it also upsets the muscular balance in this area and these teeth are bound to be forced lingually by muscular pressure when support is taken away.

Those with crowded permanent anterior teeth nearly always have had deciduous anteriors with little or no spacing. Not all who have had deciduous anteriors without spacing develop crowded permanent incisors. The difference is some additional growth but the problem is how to predict when it is going to occur. Perhaps percentile stature position may be of help in determining potential future growth.

If the distance of one half or more of a premolar is lacking on both lower sides, then serial extraction is indicated. If the shortage of space is less than one half of a premolar on each side, serial extraction should only be applied if we are dealing with a petite individual. If the lowers are crowded, the upper must also have serial extraction instituted. Some aids to this determination are the measurements of the teeth in the mouth and in the x-rays, and measurements on models of the space that is available for the various permanent teeth.

If any permanent teeth are missing or deficient in development or malposed, the extraction sequence and program is altered, but not eliminated.

In a marginal case, placing a lingual arch has dubious value whether it is intended to prevent lingual positioning of incisors or to prevent forward positioning of molars. It can never permanently remove the threat of mesial drift of the posterior segments and lingual positioning of incisors if there is a tendency for that to occur.

Regardless of the discrepancy in the sizes of the deciduous second molar and the second premolar, rarely is there any gain of additional space when the second deciduous molar is exfoliated. The first permanent molar is usually destined to move (incline) mesially the full distance of the discrepancy. On the other hand, there can be some gain of space when the first deciduous molar is lost, but only if it is much larger than the first premolar. There is a loss of space when the permanent cuspid erupts because the deciduous cuspid is smaller, except when the permanent cuspid erupts more labially. In a marginal case these factors are of importance, while in very crowded cases they should not affect the decision for extractions. About eighty per cent of Class I crowded cases are not self-correcting. Of the remaining a significant proportion end with impacted or partially erupted mandibu-

lar third molars, especially if lower incisors have been crowded.[2] The greater the discrepancy between tooth size and bone support in Class I cases, the better is the prognosis for serial extraction.

Cephalometric x-rays seem to indicate that the reduction of Class II malocclusions without extraction seems to result from a difference in the rate of forward movement of the upper and lower molars, treatment having slowed the uppers. It must be remembered that Class II cases usually are not self-correcting.[2] If the upper first molar is driven distally, we can strain the lower anchorage with crowding eventually resulting. Also the upper anteriors can relapse, the upper second molars can be displaced buccally and the third molars can become impacted.

If the lower arch is crowded in a Class II case, the upper anteriors can be retracted and the molar relation corrected first and then serial extraction can be initiated or continued. If the lower arch is not crowded, the upper anteriors can be brought lingually with the extraction of the upper deciduous cuspids (after all anterior spaces have been closed and if the permanent cuspids are high enough in the bone) and then serial extraction technique can be applied to the uppers only.

Class III cases usually are fraught with too many complicating factors to be simply treated with serial extraction unless they are pseudo-Class III.

Habits should be readily ignored as far as deciding whether a case should be treated with serial extraction. If there is an open bite, sometimes there is a closure of a varying degree when the deciduous cuspids or permanent premolars are extracted.

Bimaxillary protrusive cases without crowding cannot be beneficially handled with serial extraction without extensive appliance therapy and a closure of the bite.

Marginal cases can usually be decided on general bone structure. Usually a petite individual will be very limited in growth, while a sturdy individual will have a fair amount of potential growth.[3] The following conditions can also place borderline cases into the serially treated area: rotated upper molars and tipped lower molars, necessity of Class II elastics later, open bites, posterior cross bites and a pseudo-Class III tendency. At the conclusion of serial extraction, if it has been applied to a marginal case, active orthodontic treatment will probably be necessary. Even though teeth appear to be only slightly crowded initially, they tend to become more crowded with age, never less (without any extractions).

Techniques of Serial Extraction

It would be very nice if it were possible to have set rules whereby procedures could be followed in order to obtain certain rules. However, this is not possible with the variables we encounter in everyday orthodontic practice especially in serial extraction cases. Serial extraction cannot always be accomplished without appliance therapy, but the true objective should be to eliminate it. It is successful if it minimizes orthodontic appliance needs. By the timely removal of teeth in developing dentures, serial extraction allows unerupted, erupting, or erupted teeth to guide themselves to improved positions which are more stable than orthodontically moved teeth. Serial extraction procedures should be more of a series of observations and guidance with changing approaches as the patient's oral-facial complex develops. Prefixed concepts with any individual should not be utilized when we are dealing with a living biological organism such as man. All decisions are tentative and quite

liable to be altered at future visits. Every case must be judged individually and carefully supervised.

The well-spaced time intervals between the various stages are designed to permit a new appraisal of the growth potential in each individual patient before the next series of extractions are undertaken. There is a best time and a best sequence to extract that is different for each individual. Extraction nearest to the area of crowding is preferable whenever possible.

The lower central incisor usually erupts first at which time the relative size and shape of the teeth can be realized and confirmed by x-rays. If there is sufficient crowding and the lower permanent laterals are positioned deep in the jaw, then the lower deciduous laterals and remaining deciduous centrals are extracted. On the other hand, if the permanent laterals are within six months of erupting, then the deciduous cuspids also should be extracted. If the crowding is not extreme and the permanent cuspids are nearer to erupting than the first premolars, it is best to leave the deciduous cuspids in as long as possible. It is better in the ideal serial extraction to have the first premolars erupt before the cuspids, as occurs three fifths to two thirds of the time in crowded cases. The earlier the extraction of the deciduous teeth is started, the more self-correcting are the rotations and overlap of the teeth. Any suspicion of prolonged retention of deciduous incisors should be dealt with by prompt extraction of the offending teeth.

Unless the teeth are very crowded, extractions should not be done early if the lowers are lingually inclined, especially if there is a fairly deep bite. The bite will deepen considerably unless, later in the technique, the lower second premolars or the permanent first molars are extracted rather than the first premolars. If the permanent lower lateral incisors have a distal inclination due to pressure from the erupting permanent canines, extraction of the deciduous canines will increase this inclination.

Upon the eruption of an upper central incisor extract any remaining deciduous centrals and the deciduous laterals. The upper deciduous cuspids are only extracted if the permanent laterals are low and near eruption.

When the deciduous cuspids are extracted because of lower anterior crowding, the lower anteriors can tip lingually and erupt more, which deepens the bite. Therefore, perhaps in deep bites, with severe crowding, the deciduous first molars should be extracted instead of the deciduous cuspids. But, the extraction of the first deciduous molar probably does not help the first premolars to erupt first because the mesial root of the deciduous molar is often over the cuspids. If the canine might erupt before the first premolar, the first deciduous molar is removed followed approximately six months later by the second deciduous molar. This allows the unerupted first premolar to move distally as the canine erupts.[4] The extraction of the deciduous first molar should not be made too early in extremely crowded cases because the second deciduous molars and the first permanent molar will drift too far mesially resulting in crowding. To hasten the eruption of the first premolars, the deciduous first molars should be extracted after twelve years of age if they still have one half or more of their roots remaining.

A variety of techniques altered to suit individual requirements for the extraction of premolar teeth at various developmental stages can probably be used with equal success. Premature enucleation of embedded premolar tooth buds is wrong, except when more

than one half to two thirds of the root is formed or when the cuspid erupts first. In marginal cases, on the contrary, extract as early as possible (when the premolar just erupts and has the shortest roots) so that the posterior teeth have the longest possible time to drift mesially. Usually if a tooth drifts after eruption there is some tipping, while before eruption a tooth drifts upright bodily in bone. If the upper arch is crowded, the extraction of only the upper first premolars is indicated if the lower is not crowded.[5] Without extractions in a Class II, Division 1 case, there is very often a tendency for the relapse of the upper anteriors after treatment and a resulting crowding in the lower arch. If the upper first premolars are extracted serially, there can be some correction followed by active treatment that produces a more sustaining result. It is better to extract the second premolar in borderline cases even if the first and second deciduous molars have to be extracted to accomplish it as soon as possible.

Timing is of the greatest importance if an extraction program is undertaken. Serial extraction is a procedure of patience, of preliminary supervision without mechanical treatment, and of accurate timing in the extraction technique; the sequence should follow in an orderly manner. At critical times it is necessary for visits to be relatively frequent, monthly; at other times, every three months. After extraction of the premolars, a check should be made every three months to see that the molars do not encroach on the space remaining. Otherwise a removable space maintainer is necessary, perhaps even with springs, to increase any marginal spaces.

Before any steps in a serial extraction program can be decided on, it must be determined whether the second premolars are present and if they are properly developing. If any second premolar is not, all decisions must be delayed for the extraction of the first premolar until it can be determined that the second premolar is going to erupt and that it will be properly developed (Figs. 1 and 2).

If, in a crowded case, the permanent cuspid in the bone appears to be deeper

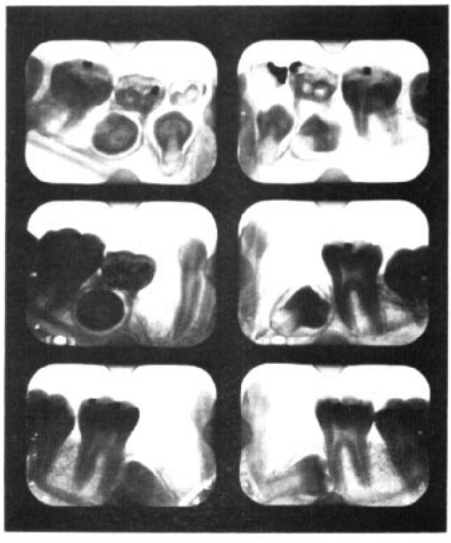

Fig. 1 Horizontal impactions possibly resulting from early serial extraction. Right and left lower posterior apical x-rays. Top, age 10:9, Middle, 11:9, Bottom, age 14:4.

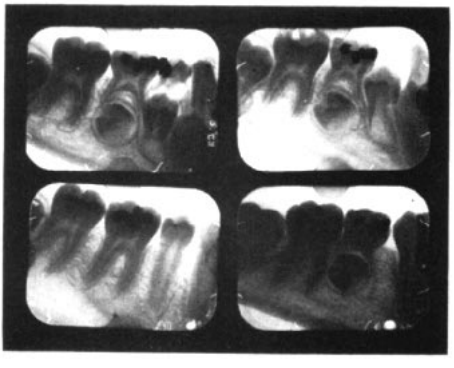

Fig. 2 Normal development and eruption after serial extraction. Right lower posterior apical x-rays. Top left, age 8:5, Top right, age 10:3, Bottom right, age 11:3, Bottom left, age 13:10.

or as deep as the first premolar, the deciduous cuspids can be ground interproximally in marginal cases instead of extracting them. If the permanent cuspid starts to erupt before the premolar, the first deciduous molar and the first premolar should be extracted, or the first and second deciduous molars extracted if the second premolar is a future candidate for extraction. With a complete abnormal position of the permanent canine, it may be extracted instead of the premolar.

Upper anterior arches that appear pointed in shape do not improve with serial extraction (Fig. 3). However, this can probably be avoided if serial extraction is started before the eruption of the upper anteriors. In cases with pointed arches, after the deciduous cuspids are extracted, the upper anteriors that are somewhat horizontally oriented can be brought lingually with the use of a Hawley with hooks for elastics that also round out the arch (Fig. 4). With this approach we obtain tipping of the anteriors. To bring upper anteriors that are vertically oriented lingually, a Hawley adapted with a light wire, as in the Begg technique, can be utilized (Fig. 5); in this manner we obtain a bodily movement of the teeth as well as a rounding of the anterior arch.

Serial extraction is more suitable in cases of normal overbite or even open bites than in cases of deep overbite. Treatment involving extraction, serial or otherwise, tends to increase the overbite and this effect seems to be intensi-

Fig. 3 Models before and after serial extraction; age 8:5 and 11:3.

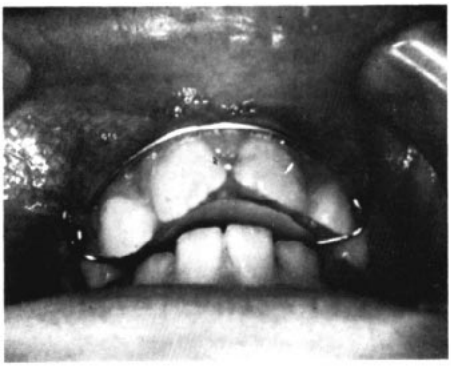

Fig. 4 Hawley with hooks for elastic retraction.

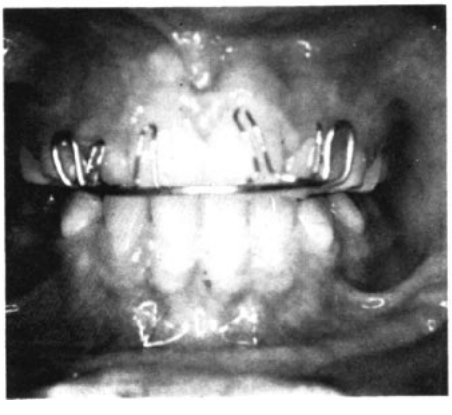

Fig. 5

fied the farther forward the extracted teeth are in the mouth. If the bite is already closed and there is no other contraindication, a tooth farther back than the first premolar in the mouth may be considered because there is less closure of the bite. You usually do not get such a closure with the extractions of the first molars[6] which tends to indicate that closure of the bite is due to a constriction in the cuspid areas resulting in a lingual inclination of the lower incisors. With the extraction of a tooth farther back in the mouth, there usually is required more active treatment after the serial sequence is finished. There are cases where the extraction of first molars done early enough will not leave any spaces and little, if any, crowding anteriorly.

The bilateral loss of deciduous teeth usually is essential or otherwise a midline of the anterior teeth develops which does not correspond with the facial center line. Therefore, if unilateral exfoliation occurs, the remaining unilateral deciduous teeth must be extracted unless there are indications that they will be lost within three months or unilateral permanent extractions are to be considered. Midline deviations are usually not corrected by the technique of serial extraction. One must either prevent their occurrences or use active appliance therapy.

If the first permanent molars or second premolars have large fillings, they should be extracted in preference to the first premolars, especially if the bite is also closed. If the lower first permanent molars are to be extracted, it should be accomplished prior to the eruption of the second molar as this latter tooth tends to tip mesially if it has already erupted. In the maxilla it is better to delay the extraction of the permanent first molar until the second molar is erupting because this tooth moves forward readily into a mesial position.

Serial extraction of the lower arch is probably the best compromise possible when the upper permanent laterals are missing. Allowing the permanent cuspids to erupt next to the central incisors gives the best possible result. With a lower permanent anterior or two missing, the upper first premolar extractions are very desirable for a stable result. If the second premolar is missing, the second deciduous molar should be extracted early with the deciduous cuspids so that the first premolar will have time to drift distally. If upper permanent cuspids are missing, lower premolars should still be extracted but, if permanent molars are missing, molars should be extracted on the same side and premolars or molars on the opposite side.

If there is any anterior spacing as a result of early serial extraction, it is difficult to get permanent closure until the extraction of the premolars because of the pressure from the crown of the cuspid on the root of the permanent lateral causing its crown to tip distally. Individual bands on the separated teeth with elastic cord around the involved teeth will usually give a good correction of remaining anterior spaces, especially after the cuspids erupt.

Results

Serial extraction avoids one form of orthodontic negligence. In discrepancy cases teeth are not first required to assume positions of extreme irregularity and then be subjected to extensive orthodontic movement to restore normal alignment and occlusal relations. They are, instead, permitted to take these positions as naturally as possible. Serial extraction helps to reduce or correct malrelations between tooth size and that of their supporting and enveloping structures, but an ideal result cannot be guaranteed, just a less severe malocclusion. A properly carried out correction does not need retention.

There may be unfavorable sequelae that may require treatment after all the teeth have erupted, such as a deepening of the overbite, rotation of teeth, failure of complete space closure and lingual collapse of the mandibular arch.

Serial extraction aids in preventing upper canine impaction and assures the probability of the functional eruption of the third molars.

Function contributes to the problems of retention. Changing the positions of teeth artificially does not guarantee stability because the teeth are not necessarily set into positions where functional forces are in equilibrium. If correct treatment is performed, theoretically there should be no retention problem. After serial extraction is completed, the teeth are relatively stable without a retention problem.

An ideal occlusion is a hypothetical concept which no individual ever attains, since in one or more details perfection is lacking. From the standpoint of orthodontic stability and function, the importance of orthodontically attaining textbook-ideal occlusal relations of the teeth has been overstressed, although it is an ideal for which we should strive. Serial extraction eliminates excessive stress on dental anchorage units, and shortens, and sometimes eliminates the period of active treatment.

The civilized jaw is apparently becoming too small to permit a regular and normal arrangement of the teeth. If sufficient space is not present, the eruption of the third molar cannot be expected.[7,8] The extraction of teeth simulates the extensive mesiodistal attritional reduction of tooth substance in Stone Age man.[9]

Four-fifths of impactions of third molars are caused by improper vertical growth, extremely short jaw length, extreme alveolar retrognathy and retarded maturation of the teeth.[8]

Teeth are continually moving mesially during the growth period.[10] Orthodontic treatment entailing the loss of lower teeth is followed by the forward movement of teeth in the lower buccal segments providing the required space that allows the eruption of the lower third molar teeth.[11] Teeth posterior to an extraction gap move forward during growth.[10,12]

With the probable third molar impaction, prophylactic extraction of teeth should be considered.[8] Second molars extracted to make room for third molars work very well.[13,14] By the extraction of premolars, the lateral arch segments move forward in treatment and thus allow more space for the eruption of the third molars.[7,15] The lower third molar erupted in some cases seven years early where there was a previous loss of permanent teeth.[11]

Summary

Serial extraction is realistically used to minimize the need for orthodontic appliance therapy although the goal should be the elimination of all appliance therapy, impossible as it is.

Selection is very important for the success of serial extraction although no exact method exists. There are many factors that help in making a decision. Serial extraction for the most part is a series of observations and advisements that are in a state of flux. Timing of the various steps is very important. All possible steps should be taken to decrease the chances of increasing a deep bite, the main disadvantage of serial extraction.

Serial extraction terminates either with no appliance therapy necessary, simple removable appliances helpful, or fixed appliance therapy necessary. The result is always more stable than any other technique.

Conclusions

Serial extraction is a technique that

mainly minimizes malocclusion so that either active appliance therapy is unnecessary or, preponderantly, of a minimal nature.

In the selection of any case for serial extraction there are no absolute formulas, just guides.

The deepening of the bite occurs when there is lingual movement of the lower anteriors.

With deep bites the emphasis in serial extraction should be on the extraction of the second premolars or the first molars.

The end product of serial extraction is a stable result accomplished with minimum stress on teeth and bone.

Serial extraction has limitations like any other orthodontic technique, but is useful and has a place in orthodontics when it is understood and properly applied.

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