ORIGINAL ARTICLE

The Royal London Space Planning: An integration of space analysis and treatment planning

Part II: The effect of other treatment procedures on space

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The Royal London Space Planning process is carried out in 2 stages. The first stage, assessing the space required to attain the treatment objectives, was described in Part I of this report, published earlier. In Part II, the process of integrating space analysis with treatment planning continues with consideration of the effects other treatment procedures have on space. These procedures include tooth enlargement or reduction, tooth extraction, the creation of space for prosthetic replacement, and mesial and distal molar movement. The effects of favorable and unfavorable growth are also considered. A brief case report is presented to demonstrate use of the Royal London Space Planning. (Am J Orthod Dentofacial Orthop 2000;118:456-61)

Part I of this 2-part article, published on page 448 in this issue of the *Journal*, described the first stage of space planning. During this stage, the space implications of various component parts of a malocclusion, including the effects on space from treatment planning decisions on arch width, incisor advancement or retraction, leveling occlusal curves, and correcting incisor angulations and inclination, are quantified.

In the second stage, any additional space to be created or used during treatment is assessed. The analysis is recorded on a form, illustrated in Table I of the case report in this article. (See Part I, Table II for guidance notes.)

ASSESSMENT OF ADDITIONAL SPACE CREATION AND USE

Tooth Reduction and Enlargement

Individual teeth of incorrect size in relation to the other teeth (eg, small lateral incisors) may not appear to present problems for alignment, but good occlusion can only be achieved when the amount of tooth material in both arches is in proportion. Therefore, a space requirement exists for the creation of space alongside small teeth for eventual enlargement. Conversely, space is gained from reducing the mesiodistal width of an unusually broad tooth or from approximal enamel reduction.

Extractions

The space gained by extraction is not entirely available for relief of anterior crowding unless the posterior teeth are prevented from moving forward. Where no anchorage reinforcement is used, the net space available is determined by several factors, including the following:

- Which teeth are extracted
- Which arch is considered
- Whether second molars are banded
- Whether the crowding is located anteriorly or in the buccal segments
- The degree of incisor crowding and therefore the amount of canine retraction
- The angulation and inclination changes needed mesial of the extraction spaces
- The angulation of teeth distal to the extraction spaces

These wide-ranging variables make it impossible to recommend a percentage space available after loss of first or second premolars. Literature searches are not particularly helpful because space availability studies were primarily carried out many years ago at a time when judgments were based on observation rather than scientific investigation, and also because these studies did not always consider the variability of anchorage demands of individual cases. For example, cases with 5 mm space deficiencies may have widely differing anchorage requirements for many of the reasons listed

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above. It is therefore wise to think in terms of a range of space availability from extractions, and it is thus necessary to base clinical judgments on the anchorage demands of each case.

Typically, 40% to 65% of first premolar space will be available for the benefit of the labial segment without anchorage reinforcement. This reduces to 25% to 50% for second premolar extractions. The net space available is less in the upper arch than for the equivalent lower extraction, as the tendency is for greater mesial movement of the upper molar.

A word of caution is necessary with regard to assessing the space creation or preservation of various anchorage devices. Lingual arches are reasonably effective as space maintainers while making use of Leeway space, but they are ineffective for reinforcing anchorage where active treatment forces are to be resisted. Nance buttons soldered to upper molar bands provide some reinforcement of anchorage in the early stages of treatment where, depending on the technique used, canine alignment and angulation are corrected. However, they must be removed before retracting or torquing the upper labial segment and are only of limited benefit when attached to premolars and used as anchorage for molar distal movement. Runge et al[1] showed there was as much mesial movement of premolars in patients treated with Jones jigs and Nance buttons as there was distal movement of the first molar. Similar loss of anchorage has been reported for the pendulum appliance.[2] The most effective means of reinforcing anchorage remains the application of headgear, although osseointegrated implant and onplant techniques may provide viable alternatives in the near future.

In the analysis, the entire mesiodistal width of the permanent teeth to be extracted is recorded, and mesial movement of the posterior teeth is recorded separately. The loss of distal units, second or third molars, is not recorded.

Absent Teeth

The initial assessment of crowding and spacing does not take absent teeth into consideration. Thus, the decision to open space for the prosthetic replacement of absent teeth is an extension of the principle of building up small teeth. For example, the space to be taken up by a prosthetic upper lateral incisor is recorded as –6 mm to –7 mm.

Distal and Mesial Molar Movement

The distal and mesial movement of molars requires particularly careful consideration. Except in unusual cases where the molar relationship is perfect Class I at the outset, or where treatment is carried out in one arch only, changes in molar relationship will inevitably involve a combination of relative mesial and distal movements. Thus, these changes will usually involve some of the following:

- Distalizing headgear
- Protraction headgear
- Intra-arch traction
- Anchorage loss
- Intermaxillary elastics
- Functional appliances
- Orthognathic surgery
- Natural growth

Clearly, this aspect of space planning is undertaken at the same time as decisions on mechanotherapy are being made. For example, should a given Class II molar relationship be converted to Class I by means of headgear, intermaxillary elastics, or functional appliances, or will orthognathic surgery be necessary? The anchorage demands of the labial segments are also relevant; correcting the angulation and inclination of teeth may be associated with only small amounts of space, but these factors may be very significant in terms of anchorage with greater mesial movement of the molars during treatment unless additional measures are taken to control anchorage.

Differential Maxillary/Mandibular Growth

Space planning requires an assessment of the difference in A/P growth between the maxilla and mandible. In the majority of cases in the permanent dentition, there will be little quantifiable difference between upper and lower anteroposterior growth during the period of treatment. The most relevant are Class II and Class III malocclusions, particularly in boys, with normal lower face heights or with forward mandibular growth rotations, and where there is a significant horizontal component of growth. In such cases, untreated Class II mandibles are observed to catch up a little during the mid to late teen years,[3] whereas Class III cases may become more severe.

The effect of favorable mandibular growth in some Class II patients is to reduce the overjet. However, in space planning terms, there is a paradox as the additional mandibular growth is equivalent to reducing upper arch space requirements, and a +2 mm upper arch score (1 mm per side) might be given in appropriate cases, in addition to the changes anticipated from treatment.

Conversely, the deterioration in Class III cases has no impact on the upper arch but can significantly increase the space requirement in the lower arch. Space for additional lower incisor compensation should thus be planned, (eg, –2 mm to –4 mm).

Table I. Completed space planning form for case 1

ROYAL LONDON HOSPITAL - ORTHODONTIC SPACE PLANNING

Patient's name: _____ Date: _____

Treatment objectives:

1. *Class I molar relationship*
2. *Dental alignment*
3. *Overbite reduction*
4. *Correction of incisor inclination*
5. *Class I incisor relationship*

Space requirements:
+ = *Space available or gained*
– = *Space required or lost*

	LOWER		UPPER	
Crowding and spacing:	–5	mm	–6	mm
Leveling occlusal curve:	–1	mm	–2	mm
Arch width change:		mm	+1	mm
Incisor A/P change:	+6	mm	+6	mm
Angulation/inclination change:		mm	–3	mm
TOTAL	0	mm	–4	mm

Space creation/utilization in addition to any planned above

Tooth reduction/enlargement: (+ or–)				
Extractions: None	+	mm	+	mm
Space opening for prosthetic replacement:	–	mm	–	mm
Molar distal movement	+	mm	+2	mm
Molar mesial movement:	–	mm	–	mm
Differential U/L growth: (+ or –)		mm	+2	mm
RESIDUE (should = 0)	0	mm	0	mm

Residual Space at Completion of the Analysis

Once all the aspects of treatment planning and the space implications of the mechanics are assessed, the residual space requirement for each arch should return to zero. If this cannot be achieved, it may signify either that the treatment objectives cannot be attained or that different treatment mechanics are necessary.

CASE REPORT

A case is presented to illustrate the use of Royal London Space Planning. The case selected is not especially complex; rather a routine orthodontic case was selected to demonstrate how the analysis helped in the treatment planning stage.

This patient presented at 11 years with a Class II Division 2 incisor relationship. Pretreatment photographs are presented in Fig 1 and the cephalometric tracing in Fig 2. The completed space planning form is presented as Table I.

Crowding in the lower and upper arches was 5 mm and 6 mm, respectively; the space required for leveling the occlusal curves was 1 mm for the lower arch and 2 mm in the upper arch. Correction of the anteroposterior relationship of the buccal segments required an additional 2 mm of width, generating 1 mm space in the upper arch. The plan was to advance the incisors in both arches by 3 mm, thus yielding 6 mm of space in each arch. The rationale for advancing the lower incisors in this type of malocclusion has been well described by Selwyn-Barnett.[4] The lower incisors were to be brought forward into space occupied by the crowns of the overerupted upper incisors, without encroaching on the labial soft tissue envelope. The upper incisor palatal root torque would require 3 mm additional space in the upper arch, recorded as –3 mm.

Having made decisions on the aims of treatment in terms of positions of the labial segments and arch widths, the total space requirement in the lower arch was zero, indicating there was just sufficient space within the arch for alignment without extractions. In the upper arch, there remained a space deficiency of 4 mm. This difference can be explained by the molar relationship, which was between Class I and one half unit Class II.

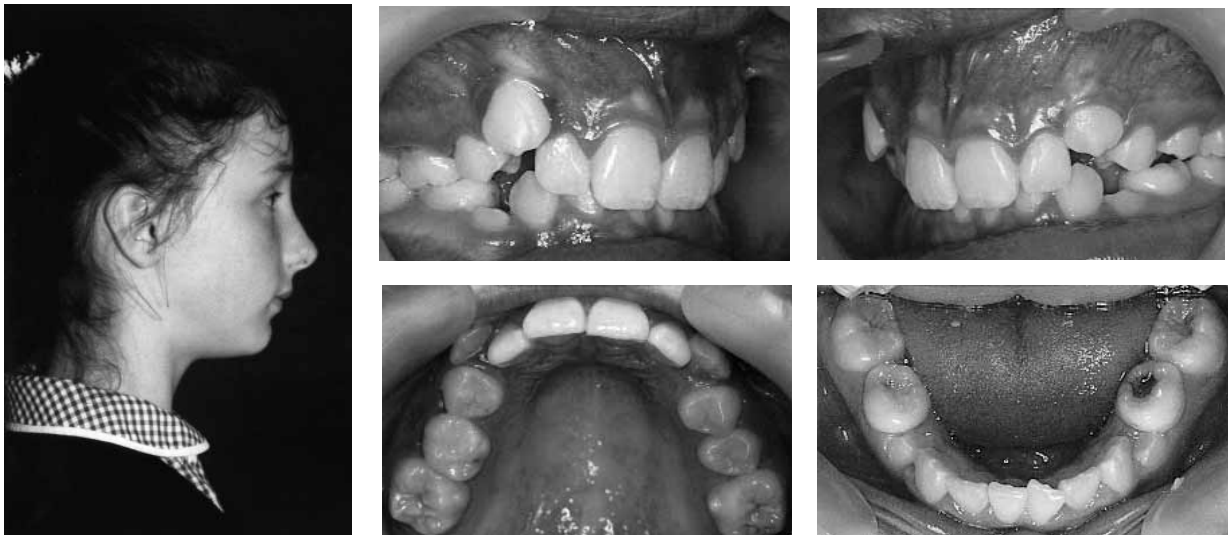

Fig 1. Case 1, pretreatment clinical photographs.

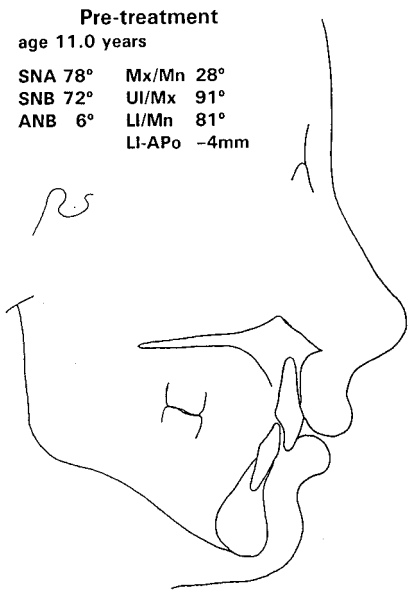

Fig 2. Case 1, pretreatment cephalometric tracing.

It was necessary to select the appropriate mechanotherapy for correcting the Class II nature of the malocclusion, and to identify a source of anchorage to support anticipated tooth movements in the upper arch, including intrusion and upper labial segment torque. Many patients with Class II Division 2 malocclusions can be treated by applying Class II elastics to fixed appliances or by converting the malocclusion to Class II Division 1 and correcting the subsequent arch relationship using a functional appliance. With such strategies, an allowance of at least 2 mm per side for lower arch anchorage loss would need to be recorded in the form of a space deficit of –4 mm under "lower molar mesial movement." However, the first part of space planning showed there was no surplus of space in the lower arch and that it would be inappropriate to use the lower dental arch as a source of anchorage. The anchorage to rectify the upper arch space deficit would thus need to be based on headgear. It was anticipated that headgear would move the upper molars distally 1 mm on each side, for a total space gain of 2 mm, and that differential mandibular growth would reduce the upper arch space requirement by a further 1 mm per side. Paradoxically, mandibular "catch-up" growth in Class II cases is thus recorded as a maxillary space gain.

Treatment was therefore carried out on the basis of an upper removable appliance with an anterior biteplane, which allowed the lower occlusal curve to be leveled at no cost to lower arch anchorage, and a headgear to retract the upper molars. A lower preadjusted edgewise appliance was fitted 4 months later and the upper removable appliance was replaced by a preadjusted edgewise appliance after a further 5 months. The total duration of treatment was 22 months, during which headgear was worn for 18 months, mainly to support the intrusion and torque of the upper labial segment. Posttreatment photographs are presented in Fig 3 and the cephalometric tracing in Fig 4.

To many clinicians, the decision to treat this patient on a nonextraction basis will not be surprising. However, space planning was most useful in determining

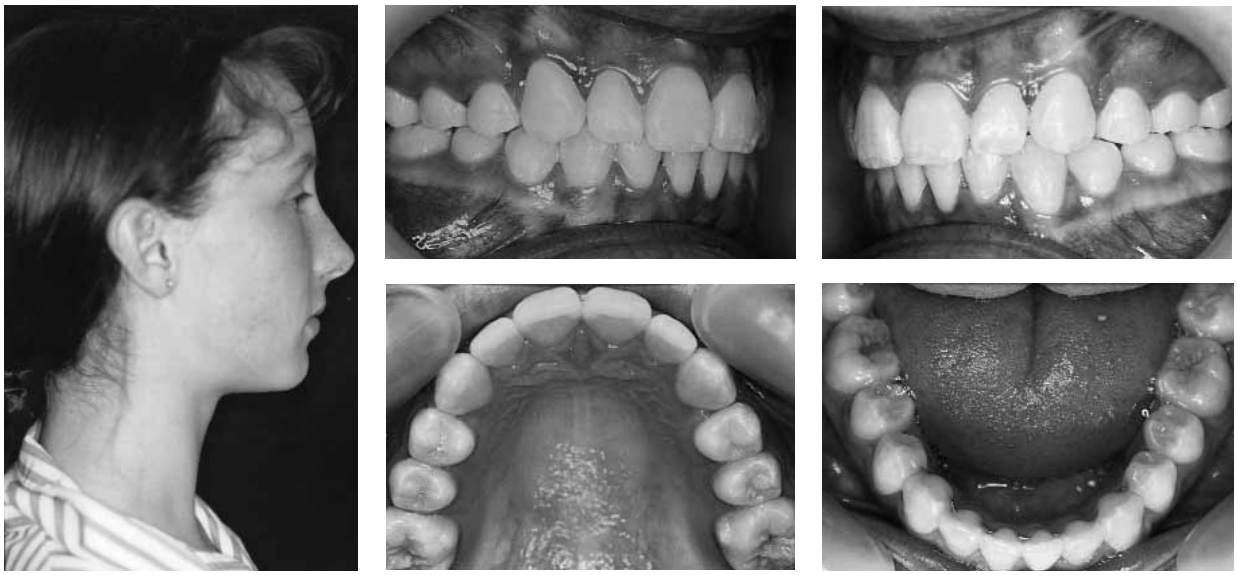

Fig 3. Case 1, posttreatment clinical photographs.

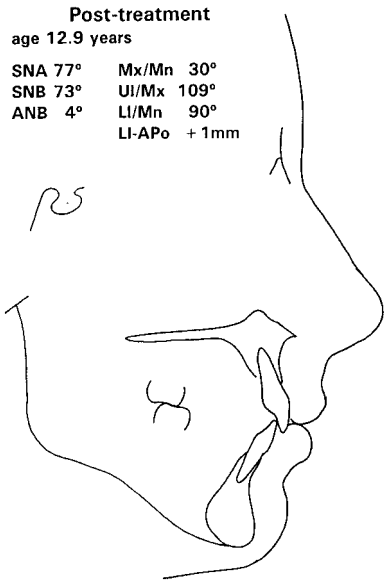

Fig 4. Case 1, posttreatment cephalometric tracing.

that the application of Class II traction, either via elastics or a functional appliance, would be inappropriate and that headgear would be necessary to meet the heavy anchorage demands of the upper arch and to prevent the lower arch from going into space deficit.

DISCUSSION

To inexperienced orthodontists, patients with complex malocclusions present with a bewildering array of factors. Over the last 15 years, students at the Royal London Hospital have found space planning to be a useful way of creating a sense of order.

Space planning can also be viewed from other perspectives. Most orthodontists will agree that extractions are too important to be left to intuition alone. Even senior clinicians are not immune from making mistakes despite their wealth of experience. Although Oscar Wilde may have gone too far when he wrote "Experience is the name everyone gives to their mistakes," the statement contains an uncomfortable element of truth. It is therefore increasingly necessary for the clinician to have clear records that justify treatment planning decisions.

A more mechanistic view is to see space planning as the mathematical manipulation of the variables that determine the size and shape of the dental arches and their relationship to each other. The process revolves around the various definitions of archform. The archform represented by bracket slots or archwires is of therapeutic importance but is not relevant to space planning. The archform defined by incisal edges and buccal cusp tips is used to quantify arch dimensions and treatment changes. The archform described by the series of contact points is also very relevant, as this is the basis for various assessments in the analysis. A further archform that is of great relevance is the one described by the points of occlusion from the lower incisors and canines on the palatal surfaces of the upper incisors and canines. This line is not only relevant to overbite and overjet, but also to upper labial segment inclination.

The Royal London Space Planning process is not perfect. It does not take into account asymmetries, as this would add immense complication. In addition, apart from the leveling of occlusal curves, it does not consider the vertical dimension. Although vertical parameters are important in the planning and execution of treatment, the arrangement of the teeth in terms of alignment and occlusion is largely a 2-dimensional concept in relation to the occlusal plane.

Many aspects of space planning are similar to cephalometry. Neither is 100% accurate, they are guides and the need to apply clinical judgment remains. Neither can be mastered overnight, but require time and experience to gain fluency and develop a feel for what the techniques can offer.

CONCLUSION

The Royal London Space Planning process integrates space analysis with treatment planning. The first stage quantifies the space required in each dental arch to attain the treatment objectives. The second stage combines this information with the space implications of planned treatment procedures. The outcome is an ability to identify whether the treatment objectives are attainable and whether the planned treatment mechanics are appropriate. One of the strengths of the Royal London Space Planning is that it is not linked to any particular treatment philosophy or appliance technique.

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