Bilateral Sagittal Split Mandibular Ramus Osteotomy :

The influence of stripping the medial pterygoid muscle on proximal segment control for mandibular advancement procedures.

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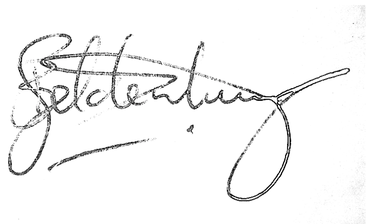
DECLERATION

I, Dr Barry Geldenhuys, ID 7702145029082, declare that this work is my own original research, unless otherwise stated, and has not been submitted for evaluation to any other institution or academic facility.



6 June 2013

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ACKNOWLEDGEMENTS

1. **Professor JP Reyneke :** For his guidance, compassion and support.
2. **Dr Jacques Beukes :** For his incredible ancillary study. His friendship, motivation advise.
3. **Mr Jason Hemingway :** For the very efficient statistical analysis.
4. **Professor MA Lownie :** For incredible departmental support.
5. **Mrs Maryam Geldenhuys :** For Being there.

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<u>AIM</u>:

One of the goals during surgical repositioning of the mandible is to ensure a correct condyle-fossa relationship and to maintain the position of the proximal segment at the time of placement of rigid fixation. During setback procedures, accurate control of the proximal segment is influenced by the medial pterygoid muscle and stylomandibular ligament. These structures are therefore stripped from the medial surface of the mandibular angle during surgery.

The aim of this study was to investigate the influence of the muscle attachment on proximal segment control in mandibular advancement surgery.

Clockwise or counterclockwise rotations of the proximal segment during surgery of two groups of patients were compared. In one group, the medial pterygoid muscle was stripped during surgery while in the other group the medial pterygoid muscle was left attached. The second group formed part of the historical development phase of the surgical technique for mandibular advancement procedures.

INTRODUCTION:

In 1957, Trauner and Obwegeser described a surgical procedure for repositioning the mandible by splitting the mandibular ramus in a sagittal plane[1]. This procedure allowed for anterior or posterior repositioning of the mandible and assisted in improving dental occlusal function as well as facial contour and esthetic appearance. This technique was later modified by Dal Pont[2] and further refined by Hunsuck in 1968[3] and Epker in 1977[4]. The Sagittal Split Mandibular Ramus Osteotomy (SSO) is currently the surgical procedure of choice for the correction of dentofacial deformities involving the mandible[5].

For mandibular setback procedures, the surgical technique requires stripping of the medial pterygoid muscles and stylomandibular ligaments. This allows for unobstructed backward sliding of the distal segment on the medial side of the proximal segment [4,5]. These structures were not routinely stripped during mandibular advancement procedures. It however, occurred to surgeons that during mandibular advancement procedures part of the medial pterygoid muscle remains attached to the distal segment while part of the muscle remains attached to the proximal segment (Fig.1). The muscle may be stretched and the orientation of the muscle changed when the proximal segment is advanced. The muscle attachments may also interfere with the free surgical advancement of the distal segment and subsequently influence accurate condylar seating.

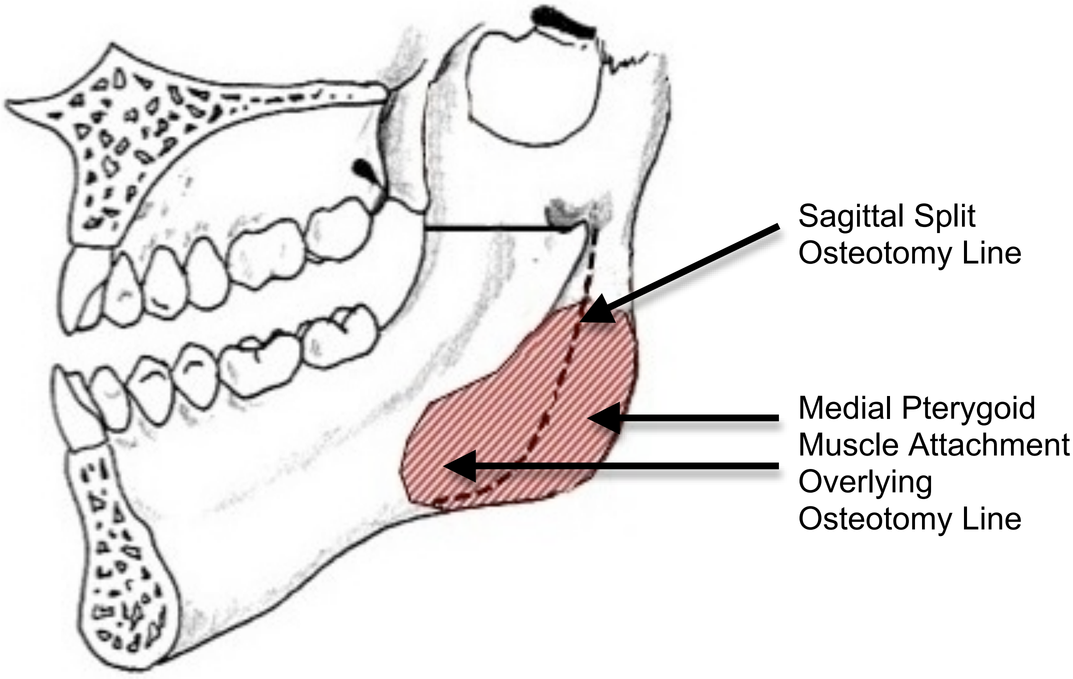

FIGURE 1: Medial pterygoid muscle attachment overlying sagittal split osteotomy line on the medial aspect of the mandibular ramus.

Our surgical technique was therefore changed several years ago by stripping the medial pterygoid muscles also for mandibular advancement procedures and it proved to increase long term skeletal stability following mandibular advancement procedures [41].

Despite improvement in surgical techniques and experience, post surgical relapse still occurs as reported in several studies[7-15, 30]. These studies have evaluated and proposed factors that could possibly influence long term post-operative skeletal stability[16-42]. Some of the factors proposed were poor proximal segment control, technical factors such as “bad” splits, high mandibular- and occlusal plane angles, condylar resorption, condylar sag, inadequate fixation periods, method of fixation, unfavorable post-surgical growth, pre-existing internal derangement of the temporomandibular joints, the age of the patient at the time of operation, inadequate bony healing, surgeons experience and density of bone[16, 20-42]. It has also been reported that larger mandibular advancements (more than 8mm) has a greater tendency to relapse than smaller advancements[17, 18].

Stripping of the medial pterygoid muscle and stylomandibular ligament attachments may aid in more accurate repositioning of the proximal segment and ultimately contribute to long-term skeletal and dental stability.

<u>MATERIALS AND METHODS</u>:

Fifty Patients who underwent Bilateral Sagital Split Mandibular Ramus Osteotomy for mandibular advancement for the correction of Class II malocclusions and mandibular antero-posterior deficiency were included in the study. No concurrent orthognathic procedures were performed and patients who required mandibular advancements in excess of 8mm were not included.

During the surgery of patients in Group 1 (twenty five patients), the medial pterygoid muscles were stripped from the angle of the proximal segment of the mandible. For Group 2 (twenty five patients) the muscles were left attached.

Cephalometric radiographs were obtained at 1 week before and 1 week after surgery as part of routine orthognathic surgical management. All radiographs were taken by the same radiographer on the same X-ray machine (Planmeca 2002 CC Prolive). One surgeon using the same technique, except for stripping of the muscles and ligaments, performed all surgeries.

Two planes were constructed on the lateral cephelometric radiograph and the angle between the planes were measured (Fig. 2):

1. SN plane: A line connecting sella and nasion.
2. A tangent line to the posterior border of the mandibular ramus ("Ramus plane").
3. Angle between the SN line and the ramus plane ("Ramus angle")

To record any change of the ramus angle the pre-operative cephalometric measurements (T0) were compared to the immediate post-operative measurements (T1).

Counterclockwise rotation was recorded as positive (+) measured angles and clockwise rotation as negative (-).

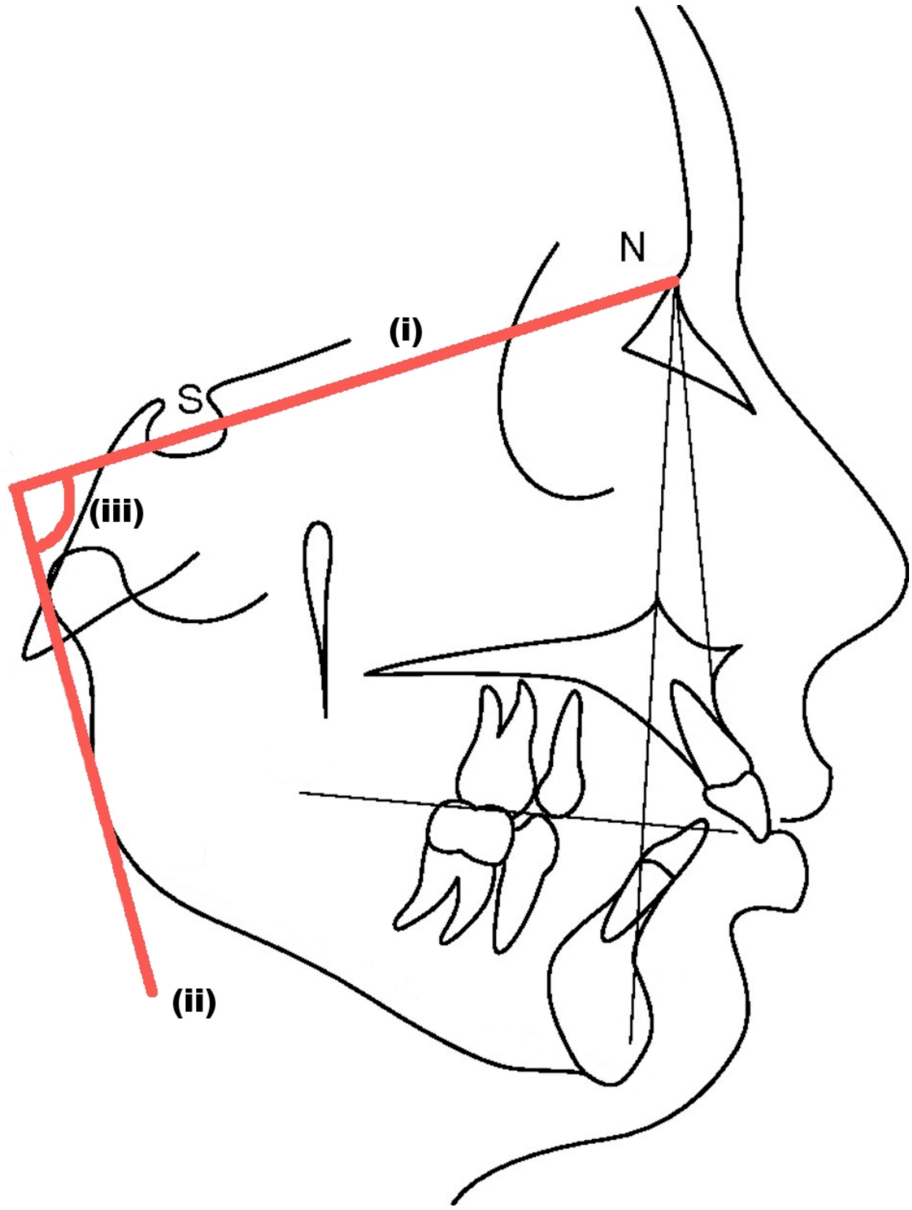

Figure 2: Cephalometric analysis demonstrating the relevant landmarks and reference lines. S = Sella is the central point of the sella

turcica as seen on a lateral cephalogram. N = Nasion is the most anterior point on the frontal nasal suture in the midsagittal plane.

i. Sella-Nasion plane (SN Line) is a line connecting Sella and Nasion.
ii. Ramus plane. A tangent line to the posterior border of the mandibular ramus and condyle.
iii. Ramus angle. The angle between the SN Line and the ramus plane.

Ramus angle changes during surgery were digitally recorded on a computer using the viewbox version 3.1.1. Software system. All data were recorded, measured and assessed by one examiner.

For intra examiner accuracy the tracings and measurements were repeated on the records of ten randomly selected patients four weeks after the initial recording by the same examiner and for inter examiner accuracy by an independent examiner. The data was statistically analyzed and any relevance recorded.

STATISTICAL ANALYSIS:

METHOD

Two analyses were performed to test firstly whether the surgical intervention significantly changed the ramus angle between the SN plane and the ramus plane in the two groups; and secondly, to examine whether there was a difference between the two groups in the mean observed angular change.

A permutation form of the paired t-test was used to assess whether surgical intervention significantly altered the angle in each group. Because of the small sample sizes permutation tests were selected over regular parametric statistics to establish significance.

Permutation tests do not make assumptions regarding the underlying parameters[42]. Their underlying premise is to test the observed statistic against that obtained by randomly reordering the samples a few thousand times, essentially creating a distribution of what could be expected by "chance". In the case of a paired t-test, individual ordering remains but the paired pre- and post-surgical observations are randomly swopped. Each analysis was compared with 10,000 permutations, and because two tests were performed, thereby doubling the chance of committing a type II error, significance was considered at an alpha level of 0.025.

A permutation t-test was used to determine whether a difference exists between the two groups regarding the observed change in angle. This method evaluates the observed t statistic, between the differences obtained for each of the groups, with the distribution obtained by randomly assigning the calculated differences to either group in 10,000 permutations, maintaining sample sizes.

Significance was considered at the 5% level.

RESULTS

Group 1: Medial Pterygoid Muscle stripped.

GENDER	AGE (Years)	T0 (Degrees)	T1 (Degrees)	CHANGE (Degrees)
F	27	+96,3	+95,1	+1,2
F	36	+92,9	+89,1	+3,8
F	31	+85,1	+84,2	+0,9
M	15	+88	+87,1	+0,9
F	15	+91	+90,4	+0,6
M	45	+86,6	+86,1	+0,5
F	14	+81,3	-84,9	-3,6
F	29	+94	+91,3	+2,7
F	14	+86,4	-88	-1,6
F	27	+87,7	+87,2	+0,5
M	54	+91,3	+88,1	+3,2
F	16	+93	+88	+5
M	19	+88,4	+83	+5,4
F	33	+87,1	+83	+4,1
M	25	+89,8	+87,3	+2,5
F	16	+88,6	+86	+2,6
M	15	+93,8	+90,1	+3,7

F	47	+92,2	+90,8	+1,4
F	15	+84,6	+82,2	+2,4
F	44	+88,8	+86,5	+2,3
F	50	+90,6	+88,3	+2,3
F	16	+90,8	+88,7	+2,1
F	32	+93,5	+89,4	+4,1
M	47	+95,1	+86,4	+8,7
M	55	+94,7	+92,2	+2,5

AVERAGE CHANGE = +2,328 (-3,6 - +8,7)

Group 2: Medial Pterygoid Muscle not stripped.

GENDER	AGE (Years)	T0 (Degrees)	T1 (Degrees)	CHANGE (Degrees)
M	34	+87,40	+83,1	+4,3
M	20	+97,50	+90,9	+6,6
F	16	+91,80	+87,7	+4,1
F	42	+86,9	+84,7	+2,2
M	17	+91,3	+87,5	+3,8
F	52	+99	+92,4	+6,6
F	43	+89,3	+83,5	+5,8
F	51	+83,3	+81,5	+1,8
F	15	+86,9	-87,8	-0,9
F	29	+90	+82,1	+7,9
M	34	+85,1	+77,7	+7,4

F	18	+88,1	-89,7	-1,6
F	32	+95,7	+92,6	+3,1
M	16	+85,7	-85,9	-0,2
F	59	+90,5	+86,1	+4,4
F	15	+89	+85,7	+3,3
F	15	+89,4	+84,2	+5,2
M	20	+91,4	+86,2	+5,2
F	29	+90,5	+84,7	+5,8
F	20	+94,2	+89,3	+4,9
F	29	+86	-86,2	-0,2
F	27	+89,1	+85,6	+3,5
F	41	+87,6	+86,5	+1,1
F	15	+89,4	+84,1	+5,3
F	16	+91,80	+87,7	+4,1

AVERAGE CHANGE = +3,66 (-1,6 - +7,9)

The permutation paired t-tests showed that both procedures resulted in a significant decrease (counterclockwise rotation) in the ramus angle of the mandible ($p<0.0001$; figure 3). Additionally, there was a significant difference between the angular change observed in group 1 when compared with the group 2 ($p = 0.030$; figure 4). This suggests that although surgical intervention significantly altered the angle in each group, there was a significant reduction in the amount of change seen in the group which the medial pterygoid muscles and stylomandibular ligaments were stripped.

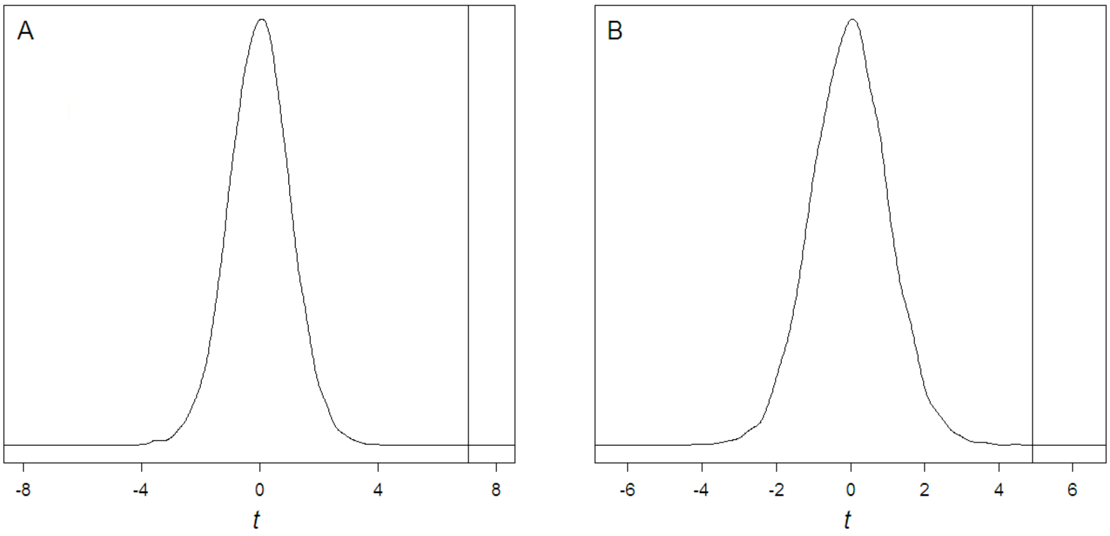

Figure 3: Results of the permutation paired t-tests for group 1 (A) and group 2 (B). The observed statistics, t = 7,047 and t = 4,907 for group 1 and 2 respectively, both lie significantly above that generated by random permutations ($p < 0.0001$).

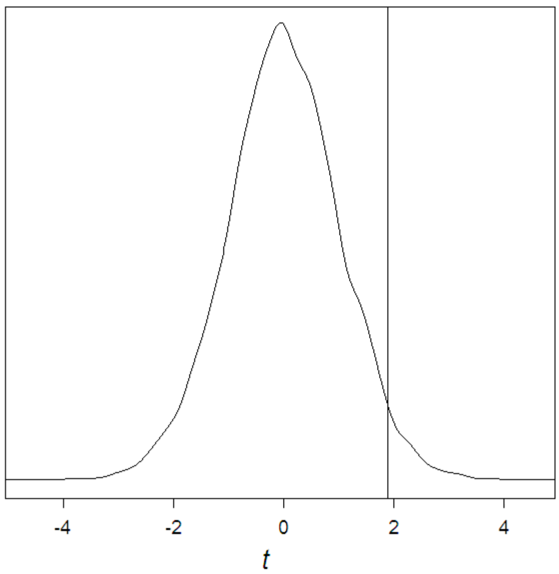

Figure 4: Results of the permutation t-tests for the angular change observed between the two groups. The observed statistics, t = 1.894, lies above that

obtained by random permutations, suggesting a significant difference in mean pre/post-operative angular change between the groups (p = 0.030).

When the distributions of results between the two groups are compared, Group 1 shows a wider range of change (-3,6 to +8,7) at the extreme ends of the results than group 2 (-2,3 to +9,3) (Fig. 6), but the median distribution of change in group 1 was smaller (Fig. 5).

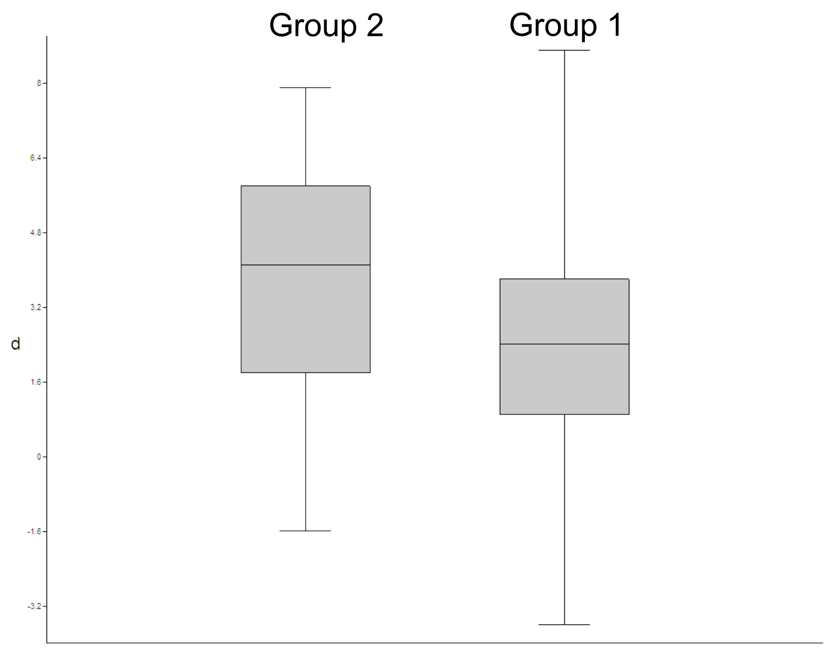

Figure 5: Comparison of the distribution of ramus angle changes between Groups 1 and 2.

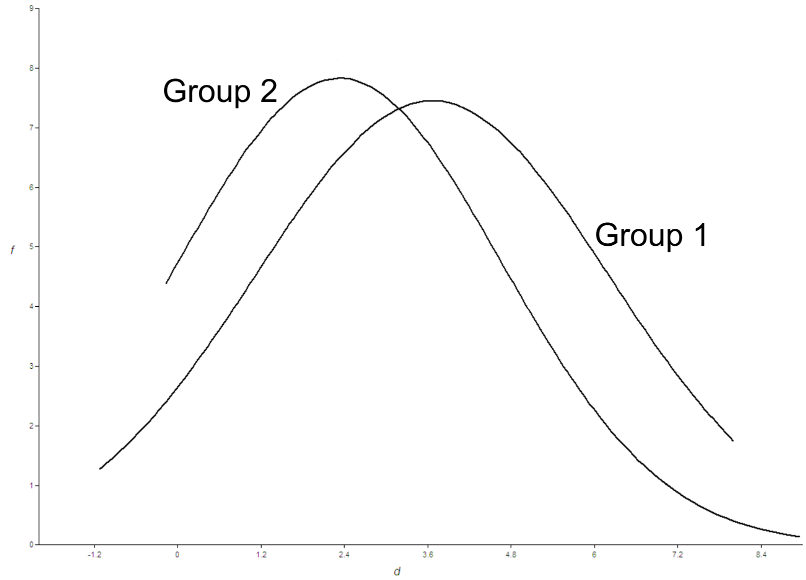

Figure 6: Range of distribution of change between Groups 1 and 2.

DISCUSSION:

In the first group (medial pterygoid muscle and stylomandibular ligament stripped), in 92% of the cases the proximal segment rotated counterclockwise and 8% showed clockwise rotation. The second group (medial pterygoid muscle and stylomandibular ligament not stripped) in 84% of cases the proximal segment rotated counterclockwise and 16% of cases showed clockwise rotation.

The extremes of the range of distribution in group 1 (-3,6 to +8,7) was more than group 2 (-2,3 to +9,3) (Fig. 6) but group 1 exhibited a narrower median distribution of change implying that the majority of cases in group 1 changed less than in group 2.

For both groups, there was a statistically significant change in the ramus angle (Fig. 3).

The ramus average angle change in group 1 was less (+2,328º) than in group 2 (+3,66º) (Fig. 5) which was statistically significant. This may indicate that stripping of the medial pterygoid muscle and stylomandibular ligament allow for better proximal segment control.

The difference in the two groups may explain the increased long-term stability found when the medial pterygoid muscle and stylomandibular ligament was stripped[41]. There may however be other contributing factors not evaluated in this study.

Because of the ramus height, a small change in the ramus angle may have an exponential effect on the linear distance at the mandibular angle during rotation (clockwise or counterclockwise) of the proximal segment (Fig. 7). For example, a 5-degree change (clockwise or counterclockwise) in a ramus height of 40mm will create a 6mm linear change if measured at the level of gonion. This change will be increased if the ramus height is increased and decreased in patients with short mandibular rami.

Several factors may influence poor proximal segment control such as surgical technique, rigid fixation, occlusion and muscles of mastication. This study suggest that stripping of the medial pterygoid muscle and stylomandibular ligament allows for better control of the proximal segment during bilateral sagittal split ramus osteotomies for mandibular advancement surgery.

To assist in acurate condylar repositioning and proximal segment control we recommend:

1.) Placement of markers perpendicular to the vertical osteotomy line. These markers facilitate accurate alignment of the lower border of the proximal and distal segments.

2.) The use of a condyle repositioning instrument.

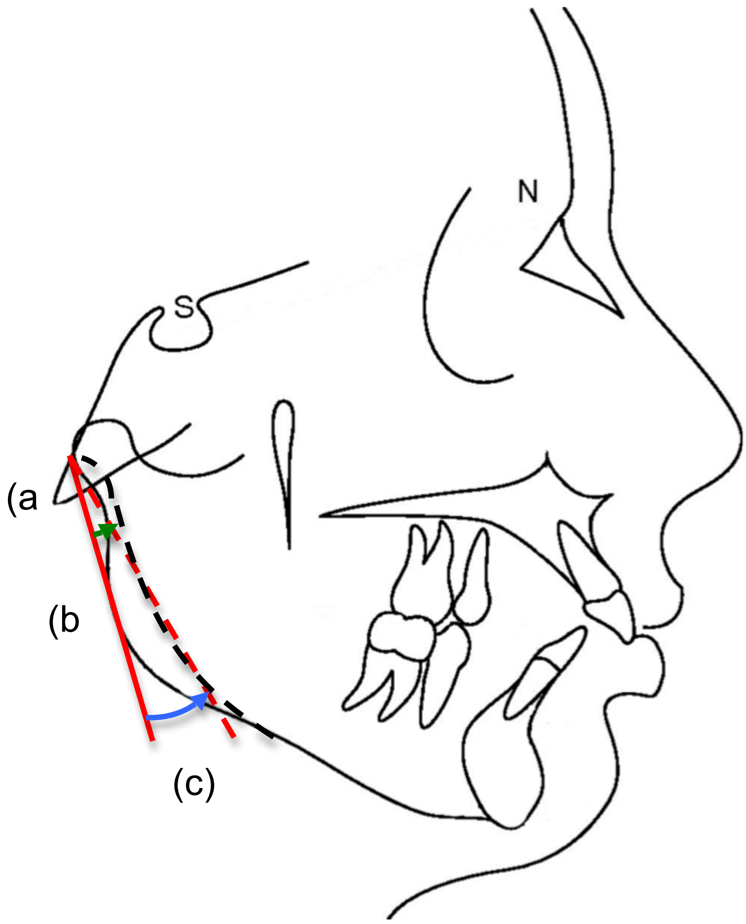

Figure 7: Linear change occurring during a small counterclockwise rotation of the proximal segment representing the potential for a larger movement to occur at the mandibular angle. (a) Simulated change of 5º. (b) Ramus height of 42mm. (c) Linear change of 6mm. Clockwise rotation will shorten the ramus height, while counterclockwise rotation will increase the ramus height.

CONCLUSION:

The angular change of the proximal segment of the two groups proved to be significantly influenced by stripping of the medial pterygoid muscle and stylomandibular ligament and the effect thereof is well illustrated by the linear change at the lower border. Clockwise rotation will shorten the ramus height, while counterclockwise rotation will increase the ramus height. Rotations of the segment will not only change the orientation of the temporalis and masseter muscles, but also their lengths. Clockwise rotation will increase the muscle length, while counterclockwise rotation will decrease the muscle length. Both these factors may influence the long-term postoperative stability. The forward (counterclockwise) rotation will lead to a less prominent mandibular angle and obtuse gonial angle with subsequent aesthetic consequences.

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