ABSTRACT

Aims: To evaluate the effects of orthodontic treatment, sex on the maxillary arch measurements, anatomical landmarks position, dimensional differences of artificial teeth selection and position on the comfort for treated partially edentulous patient; with and without previous orthodontic treatment.

Materials and Methods: two groups of patients: (Males and females) included in this study. First group were with Orthodontic group classified as: Angle class I malocclusion, crowding more than 5 mm, there were 48 in number. Second group were 32 in number, and they’re partially edentulous (with previous orthodontic treatment or without as a control group), they were selected with special criteria. A 192 dental stone casts were prepared, and 64 linear measurements were done for each individual cast of the first group, and 22 measurements for the second group. Crom–Cobalt (Cr–Co.) partial dentures were constructed for the second group individuals, follow up for 3–6 months to detect the comfort of the patient in relation to mean differences in the length measurements of the saddle area were recorded.

Results: Incisal canine dimension showed a marked expansion of right side (0.7342 mm) post orthodontic treatment, constriction in the upper inter 1\textsuperscript{st} molar distance 2.7334 mm in relation to control. Anatomical landmark (canine to hamular notch right and left post orthodontic treatment), in female showed an increase in measurements in relation to male. Length difference of free end saddle area of partially edentulous control group in relation to partially edentulous patient with orthodontic treatment was about 2.987 mm. An increase in percentage of comfort of control patients wearing removable prosthesis was shown in female.

Conclusions: Mean values of the all measurements were generally higher in the males than females post orthodontic treatment. Increase in the arc measurements, but with constructions in the inter–molar distance, anatomical landmark labial surface of the central incisors to the incisive papilla, and canine to hamular notch for both groups. Length of artificial teeth of free end partially edentulous with orthodontic treatment was reduced, but the comfort after prosthodontic treatment was higher in female of both groups.

Key words: Orthodontics, Prosthetic, comfort, landmark.

INTRODUCTION

The face by which we greet the world is the most visible part of human body. The maxillary arch dimensions are important in clinical Prosthodontics, Orthodontics, Pedodontics, Oral surgery, and other fields as: Anthropology \textsuperscript{(1)}. The orthodontic treatment for any case of malocclusion, certainly aims to create changes in teeth position in a manner to convert malocclusion into an acceptable occlusion that performs the three main demands: function, aesthetic, and phonetic. It is well established that increases in the dental arch length and width during orthodontic treatment tend to return toward pre–treatment values after retention. These dimensional changes may affect arch form and size as well.\textsuperscript{(2)} Orthodontic therapy can no longer be isolated from the increasing treatment demands of other specialties.\textsuperscript{(3)} Prosthesis must include a facial eval-
uation along with an intra oral examination when establishing treatment goals that will satisfy the patient and provide aesthetic results. Analysis of facial proportion, integument form, and dento–labial relationship at resting lip position and in a full smile, together with an occlusal evaluation, will help the clinician to design the best functional and aesthetic dental prosthesis (4–6). Aesthetic factors: the form of face, tooth and arch form, maxillary anterior tooth arrangement and palatal contour (7) and the anatomical landmarks (8,9) were used for selection of suitable tooth moulds for completely and partially edentulous patients. One of the methods of orthodontic treatment of crowding anterior teeth is extracting of bilateral first bicuspid. Extraction of premolars has an effect on the tongue space during development (9). First bicuspid has a fixative position in relation to the medial fibres of the buccinators muscle at the corner of the mouth. This position of bicuspid plays an important mechanical function during mastication and plays an important guide of maxillo–mandibular relationship (10). Aims of the study, were to evaluate the effect of the extraction of the first bicuspid on maxillary arch measurements, percentage of changes in positions of teeth in relation to anatomical landmarks, and to evaluate the dimensional differences of artificial teeth selection, also the comfortability of treated partially edentulous patient (with or without previous orthodontics).

MATERIALS AND METHODS
The first participant of this study consists of 48 patients (24 females and 24 males), age range between 15–20 years. The patients were selected from the Dental College University of Mosul. This research was completed between three and a half years (treatment and retention period), and all patients were selected according to special criteria Angle Class I malocclusion crowding more than 5 mm, no molar rotation, no anterior or posterior cross bite, clinically no detectable massive interproximal or occlusal caries, no dental restorations or fractured or crowned teeth, no supernumerary teeth, and no previous orthodontic treatments.

For each patient after extra and intra oral examination a case sheet was used to fill all information about the patient before and after orthodontic treatment. All patients had undergone fixed orthodontic treatment using edgewise technique 0.022” bracket slot. Extraction of bilateral 1st bicuspid had been done for all patients followed by retraction of canines using sliding mechanism by power chain elastic to full bicuspid width with anchorage reinforcement by using face bow head gear. A total of 192 dental stone casts were constructed for the maxillary and mandibular arches: one set before treatment and the other after final treatment and follow up after removal of retainers (three and a half years). Dental arch relationship was detected, and linear measurements were done five times for each by using digital electronic vernier (LEZACO, China) with accuracy (0.001 mm), and celluloid strip for determination of the arc distance.

A black automatic pencil (0.3 mm tip) was used to mark anatomical landmarks on the maxillary stone cast at two time periods with the aid of surveyor device and special holder to fix the digital vernia: (Pr: pre treatment, C–C: Inter canines distance, M–M1R: inter 1st molar mesio buccal cusps, M–M2L: inter 2nd molar mesio buccal cusps). Segmental length measurements include: (Cr: Incisor to cusp of right canine, ICI : Incisor to cusp of left canine, CMr: Canine to mesial cusp of 2nd right molar, CMI: Canine to mesial cusp of 2nd left molar, IMo: Vertical distance from Incisal to line between 2nd molars distobuccal cusp tip. Arc–C: arc measurement from distal canine to distal canine) (8).

Other measurements were done to determine the coincidences of anatomical landmarks in relation to natural teeth position (Pr and post treatment measurements of L1–P: Labial surface of central incisor to the anterior part of incisive papilla, P–IC: Papilla in relation to inter canine line. I–Mr1, I–M1L: Incisal to mesial buccal cusp of 1st molar right and left. I–M2L, I–M2R : Incisal to mesial buccal cusp of 2nd molar right and left. C–Hr, C–HI: Canine to Hamular notch right and left, H–H: Horizontal distance between Hamular to Hamular notches (1,8). The second participants were thirty two in number, partially edentulous Kennedy Cl II with
missing teeth distal to canine right or left side of the arches, age range: 55–61 years old, and were divided into:
• Group without previous orthodontic treatment, twenty in number.
• Group with previous orthodontic treatment (with extraction of teeth), twelve in number (very rare clinical cases). After extra and intra oral examination with recording all information, linear measurements of maxillary and mandibular casts were done in addition to the free end saddle area of the side of the maxillary arch from the distal of the canine to the maxillary tuberose area in relation to the 2/3 of retro molar pad, and for the natural teeth of the other side from distal of the canine to distal most posterior teeth (11). Cr.Co. removable partial acrylic resin denture was constructed in the conventional method with one design, which was anterior–posterior major connector. After insertion of prosthesis intra orally, correction of errors was done with follow up for 2 weeks. Each patient was examined for recording the percentage of comfort of the prosthesis after 3–6 months. Mean, standard deviation, mean differences and Two tailed correlations between male and female were determined for all the measurements of the parameters before and after orthodontic treatment.

RESULTS AND DISCUSSION
For the first participant: Mean arch dimensions along with their standard deviations, paired differences and correlations, were listed in Tables (1–4). Mean values of the all variables were generally higher in the males compared with the females and significant sex differences in the means P> 0.001 (11) for all measurements (pre and post orthodontic treatment) except for C–C, M–M1⁴, M–M2⁴, Icl, and Arc–C. The dimension of ICr showed a marked expansion post treatment as result of relieving of crowded anterior teeth in addition to the distal tipping canines during retraction (12–14). The results of this study showed a constriction in the upper inter 1⁴ molar distance 2.7334 mm. for the total sample, the results of this study was agreed with Isik et al (11), and nearly the same as the results of study that done by Boley et al (15) demonstrating a decreased in the inter molar width (~2.1 mm). The results of this study showed that the arch width changes between pre and post orthodontic treatment with extraction in the inter molar width was less than the inter canine width, these findings agreed with Hnat et al (16).

Tables (3 and 4) showed, that the range of distance between the labial surface of the central incisors to the incisive papilla of pre orthodontic treatment was 7.07–8.36 mm. for female and male respectively larger than that after orthodontic treatment, these findings were agreed with many authors (17,18). The segmental linear measurements for the incisal, canine, molars, and anatomical landmarks showed less dimensional changes with extraction rather than without extraction treatment as reported by Isik et al, and Hassanali et al (11,19).

For the second participants: Figure (1) showed that there was slight decrease in mean differences of the important linear measurements of the two samples of this group that determine the construction of the prosthesis. Figure (2) showed that the size of the selected teeth for artificial prosthesis for the second sample patient with orthodontic treatment asymmetry in the size to mach the natural appearance. These findings insure that the results of this study were agreed with many authors (20,21–25), they reported that more appropriate to use only known hard tissue landmarks in mouth width and length prediction for selection of artificial teeth to construct a prosthesis. Figure (3) showed the results of Prosthodontics finding of clinical cases with previous orthodontic treatment less comfort with prosthesis due to reduction in the length of saddle area and number of artificial teeth as reported by other study (26,27), and disagreed with other study who found that many people are satisfied with prosthesis with less than 28 teeth (28). Higgins and Lee (25) explained the location of the occlusal centre of the force is important factor for comfortable or successfulness of prosthesis. This force is not affected by the gender or age but the width and lengths of the arch are the significant factor in relation to the occlusal load centres.
Table (1): Mean differences of maxillary arch measurements pre orthodontic treatments

| Measurement | Sex    | Mean (mm.) | N | Sd     | Paired Differences | 95% Confidence Interval of the Difference | t     | df | Sig. (2-tailed) | Correlation 2-tailed | Sig. |
|-------------|--------|------------|---|--------|---------------------|----------------------------------------|-------|----|-----------------|------------------------|------|
| C-C Pr      | Female | 31.8833    | 24| 5.2503 | 0.6292              | 5.2249                                  | -1.5771| 2.8354 | 0.590           | 0.561                  | 0.141|
|             | Male   | 31.2542    | 24| 1.2680 |                      |                                        |       |     |                 |                        |      |
| M-M1st Pr   | Female | 38.6667    | 24| 5.4986 | 0.4917              | 5.0501                                  | -1.6408| 2.6241 | 0.477           | 0.638                  | 0.442|
|             | Male   | 38.1750    | 24| 1.3430 |                      |                                        |       |     |                 |                        |      |
| M-M2nd Pr   | Female | 40.8792    | 24| 4.7653 | -0.0458             | 4.5728                                  | -1.9768| 1.8851 | 0.049           | 0.961                  | 0.298|
|             | Male   | 40.9250    | 24| 0.9566 |                      |                                        |       |     |                 |                        |      |
| ICr Pr      | Female | 18.1525    | 24| 3.1056 | -1.0892             | 3.3303                                  | -2.4954| 0.3171 | -1.602          | 0.123                  | -0.008|
|             | Male   | 19.2417    | 24| 1.1784 |                      |                                        |       |     |                 |                        |      |
| ICl Pr      | Female | 18.8208    | 24| 2.6304 | -1.1208             | 2.8902                                  | -2.3412| 0.0995 | -1.900          | 0.070                  | -0.049|
|             | Male   | 19.9417    | 24| 1.0750 |                      |                                        |       |     |                 |                        |      |
| CMr Pr      | Female | 20.8292    | 24| 2.9580 | -0.1500             | 2.9243                                  | -1.3848| 1.0848 | -0.251          | 0.804                  | 0.157|
|             | Male   | 20.9792    | 24| 0.5920 |                      |                                        |       |     |                 |                        |      |
| CMI Pr      | Female | 20.4917    | 24| 3.1253 | -0.4333             | 3.1451                                  | -1.7614| 0.8947 | 0.675           | 0.506                  | 0.637|
|             | Male   | 20.9250    | 24| 0.7908 |                      |                                        |       |     |                 |                        |      |
| IMo Pr      | Female | 36.0292    | 24| 4.2874 | -3.5750             | 4.6068                                  | -5.5203| -1.6297| -3.802          | 0.001**                | 0.118|
|             | Male   | 39.6042    | 24| 2.2648 |                      |                                        |       |     |                 |                        |      |
| Arc-C Pr    | Female | 54.0133    | 24| 5.5333 | -1.9867             | 6.1244                                  | -4.5728| 0.5995 | -1.589          | 0.126                  | -0.260|
|             | Male   | 56.0000    | 24| 1.5537 |                      |                                        |       |     |                 |                        |      |

Pr: Pre treatment; C-C: Inter canines distance; M-M1st: inter 1st molar mesial buccal cusps; M-M2nd: inter 2nd molar mesial buccal cusps; ICr: Incisor to cusp of canine right; ICl: Incisor to cusp of canine left; CMr: Canine to mesial cusp of 2nd molar right; CMI: Canine to mesial cusp of 2nd molar left; IMo: vertical distance from Incisal to line between molars; Arc-C: arc measurement from distal canine to distal canine; N: Number; Sd: Stander deviation; df: degree of freedum; Sig: Significancy.
Table (2): Mean differences of maxillary arch measurements Post orthodontic treatments

| Measurement | Sex | Mean (mm.) | N  | Sd   | Paired Differences | 95% Confidence Interval of the Difference | t   | df  | Sig. (2-tailed) | Correlation 2-tailed | Sig.  |
|-------------|-----|------------|----|------|-------------------|------------------------------------------|-----|-----|----------------|-----------------------|-------|
|             |     |            |    |      | Mean             | Sd                                 |     |     |                |                       |       |
|             |     |            |    |      | Lower            | Upper                                |     |     |                |                       |       |
| InCd Po     | Female | 32.9167   | 24 | 2.4140       | -0.8917                       | 2.5222 | -1.9567 | 0.1734 | -1.732 | 23 | 0.097 | -0.024 | 0.912 |
|             | Male  | 33.8083   | 24 | 0.6756        |                             |        |        |        |        |    |       |        |       |
| M-M1st Po   | Female | 35.6125   | 24 | 2.7756       | -0.1500                      | 3.0075 | -1.4200 | 1.1200 | -0.244 | 23 | 0.809 | 0.149  | 0.486 |
|             | Male  | 35.7625   | 24 | 1.6450        |                             |        |        |        |        |    |       |        |       |
| M-M2nd Po   | Female | 39.1875   | 24 | 3.5922       | -0.3000                      | 3.7867 | -1.8990 | 1.2990 | -0.388 | 23 | 0.701 | -0.108 | 0.614 |
|             | Male  | 39.4875   | 24 | 0.8704        |                             |        |        |        |        |    |       |        |       |
| ICr Po      | Female | 18.6417   | 24 | 1.9649       | -1.5792                      | 2.1020 | -2.4667 | -0.6916 | -3.681 | 23 | 0.001** | 0.051  | 0.814 |
|             | Male  | 20.2208   | 24 | 0.8531        |                             |        |        |        |        |    |       |        |       |
| ICl Po      | Female | 18.7875   | 24 | 1.3665       | -0.5042                      | 1.6499 | -1.2009 | 0.1925 | -1.497 | 23 | 0.148 | 0.022  | 0.919 |
|             | Male  | 19.2917   | 24 | 0.9550        |                             |        |        |        |        |    |       |        |       |
| CMr Po      | Female | 15.6958   | 24 | 2.6576       | 1.8250                       | 3.0315 | 0.5449 | 3.1051 | 2.949  | 23 | 0.007** | 0.056  | 0.794 |
|             | Male  | 13.8708   | 24 | 1.6153        |                             |        |        |        |        |    |       |        |       |
| CMI Po      | Female | 15.3267   | 24 | 3.0815       | -2.1983                      | 3.0126 | -3.4705 | -0.9262 | -3.575 | 23 | 0.002** | 0.508  | 0.011** |
|             | Male  | 17.2520   | 24 | 2.9916        |                             |        |        |        |        |    |       |        |       |
| IMo Po      | Female | 31.2521   | 24 | 2.9548       | -1.3271                      | 3.7228 | -2.8991 | 0.2449 | -1.746 | 23 | 0.094 | -0.361 | 0.083 |
|             | Male  | 32.5792   | 24 | 1.4359        |                             |        |        |        |        |    |       |        |       |
| Arc-C Po    | Female | 53.8125   | 24 | 4.0269       | -1.7167                      | 4.3786 | -3.5656 | 0.1322 | -1.921 | 23 | 0.067 | -0.046 | 0.832 |
|             | Male  | 55.5292   | 24 | 1.5454        |                             |        |        |        |        |    |       |        |       |

Po: Post treatment; C-C: Inter canines distance; M-M1st: inter 1st molar mesial buccal cusps; M-M2nd: inter 2nd molar mesial buccal cusps; ICr: Incisor to cusp of canine right; ICl: Incisor to cusp of canine left; CMr: Canine to mesial cusp of 2nd molar right; CMI: Canine to mesial cusp of 2nd molar left; IMo: vertical distance from Incisal to line between molars; Arc-C: arc measurement from distal canine to distal canine; N: Number; Sd: Standerd deviation; df: degree of freedom; Sig: Significance.
Table (3): Mean differences of maxillary arch measurements pre orthodontic treatments in relation to some anatomical landmarks

| Measurement | Sex | Mean (mm.) | N  | Sd       | Paired Differences | 95% Confidence Interval of the Difference | t     | df | Sig. (2-tailed) | Correlation 2-tailed | Sig.  |
|-------------|-----|------------|----|----------|--------------------|----------------------------------------|-------|----|----------------|-----------------------|-------|
| LI-P Pr     | Female | 7.0792 | 24 | 1.5997 | -1.2875         | 1.9227 | -2.0994 | -0.4756 | -3.281 | 23 | 0.003** | -0.025 | 0.908  |
|             | Male  | 8.36724  | 24 | 1.0273 |                   |         |         |         |         |    |          |        |        |
| P-IC Pr     | Female | 4.1667 | 24 | 1.5511 | -0.1667 | 2.2001 | -1.0957 | 0.7624 | -0.371 | 23 | 0.714 | -0.106 | 0.620  |
|             | Male  | 4.3333  | 24 | 1.4039 |                   |         |         |         |         |    |          |        |        |
| I-M1^st r Pr | Female | 46.4458 | 24 | 5.3977 | 0.3333 | 2.9723 | -0.9218 | 1.5884 | 0.549 | 23 | 0.588 | 0.835  | 0.000** |
|             | Male  | 46.1125 | 24 | 4.5899 |                   |         |         |         |         |    |          |        |        |
| I-M2^nd l Pr | Female | 46.0958 | 24 | 6.1501 | -0.0333 | 3.1004 | -1.3425 | 1.2759 | -0.053 | 23 | 0.958 | 0.864  | 0.000** |
|             | Male  | 46.1292 | 24 | 5.3339 |                   |         |         |         |         |    |          |        |        |
| C-Hr Pr     | Female | 39.2542 | 24 | 6.5401 | 1.2250 | 3.2186 | -0.1341 | 2.5841 | 1.865 | 23 | 0.075 | 0.884  | 0.000** |
|             | Male  | 40.4792 | 24 | 6.7828 |                   |         |         |         |         |    |          |        |        |
| C-Hl Pr     | Female | 38.5583 | 24 | 6.4340 | 1.0750 | 3.0031 | -0.1931 | 2.3431 | 1.754 | 23 | 0.093 | 0.894  | 0.000** |
|             | Male  | 39.6333 | 24 | 6.6122 |                   |         |         |         |         |    |          |        |        |
| H-H Pr      | Female | 50.7750 | 24 | 4.8711 | 0.3000 | 2.4383 | -0.7296 | 1.3296 | 0.603 | 23 | 0.553 | 0.866  | 0.000** |
|             | Male  | 50.4750 | 24 | 4.2814 |                   |         |         |         |         |    |          |        |        |

Pr: Pre treatment; LI-P: Labial surface of central incisor to the anterior part of incisive papilla; P-IC: Papilla in relation to inter canine line; I-Mr1, I-Ml1: Incisal to mesial buccal cusp of 1st molar right and left; I-M1^st r, I-M2^nd l: Incisal to mesial buccal cusp of 2nd molar right and left; C-Hr, C-Hl: Canine to Hamular notch right and left; H-H: Horizontal distance between hamular to hamular notch; N: Number; Sd: Standard deviation; df: degree of freedom; Sig: Significance.
Table (4): Mean differences of maxillary arch measurements Post orthodontic treatments in relation to some anatomical landmarks

| Measurement | Sex  | Mean (mm.) | N  | Sd   | Paired Differences | 95% Confidence Interval of the Difference | t    | df | Sig. (2-tailed) | Correlation 2-tailed | Sig. |
|-------------|------|------------|----|------|-------------------|------------------------------------------|------|----|----------------|----------------------|------|
| LI-P Po     | Female | 6.3000     | 24 | 1.2389 | -0.9583          | -1.6311 -0.2856 | -2.947 | 23 | 0.007**        | 0.027                | 0.900 |
| LI-P Po     | Male  | 7.2583     | 24 | 1.0358 | 1.5932           | -1.6311 | -0.2856 | -2.947 | 23 | 0.007**        | 0.027                | 0.900 |
| P-IC Po     | Female | 4.5833     | 24 | 1.3805 | -0.0417          | 1.1602 -0.5316 | 0.4482 | -0.176 | 23 | 0.862         | 0.614                | 0.001** |
| P-IC Po     | Male  | 4.6250     | 24 | 1.2446 | 0.3817           | -0.5316 | 0.4482 | -0.176 | 23 | 0.862         | 0.614                | 0.001** |
| I-M1st r Po | Female | 44.1792    | 24 | 3.6813 | -0.2458          | 2.6962 -1.3843 | 0.8927 | -0.447 | 23 | 0.659         | 0.709                | 0.000** |
| I-M1st r Po | Male  | 44.4250    | 24 | 3.3331 | 2.6962           | -1.3843 | 0.8927 | -0.447 | 23 | 0.659         | 0.709                | 0.000** |
| I-M2nd l Po | Female | 43.8875    | 24 | 4.0454 | -0.9500          | 2.9627 -2.2010 | 0.3010 | -1.571 | 23 | 0.130         | 0.710                | 0.000** |
| I-M2nd l Po | Male  | 44.8375    | 24 | 3.6886 | 2.9627           | -2.2010 | 0.3010 | -1.571 | 23 | 0.130         | 0.710                | 0.000** |
| C-Hr Po     | Female | 37.1125    | 24 | 5.8644 | 1.5250           | 3.7416 -0.0549 | 3.1049 | 1.997 | 23 | 0.058         | 0.816                | 0.000** |
| C-Hr Po     | Male  | 35.5875    | 24 | 6.3708 | 3.7416           | -0.0549 | 3.1049 | 1.997 | 23 | 0.058         | 0.816                | 0.000** |
| C-Hl Po     | Female | 36.5458    | 24 | 5.7305 | 0.4792           | 2.0629 -0.3919 | 1.3503 | 1.138 | 23 | 0.267         | 0.933                | 0.000** |
| C-Hl Po     | Male  | 36.0667    | 24 | 5.4046 | 2.0629           | -0.3919 | 1.3503 | 1.138 | 23 | 0.267         | 0.933                | 0.000** |
| H-H Po      | Female | 50.6375    | 24 | 4.8121 | -0.0583          | 2.4954 -1.1120 | 0.9954 | -0.115 | 23 | 0.910         | 0.857                | 0.000** |
| H-H Po      | Male  | 50.6958    | 24 | 4.3983 | 2.4954           | -1.1120 | 0.9954 | -0.115 | 23 | 0.910         | 0.857                | 0.000** |

Po: Post treatment; LI-P: Labial surface of central incisor to the anterior part of incisive papilla; P-IC: Papilla in relation to inter canine line; I-Mr1, I-M1st: Incisal to mesial buccal cusp of 1st molar right and left; I-M1st r, I-M2nd l: Incisal to mesial buccal cusp of 2nd molar right and left; C-Hr, C-Hl: Canine to Hamular notch right and left; H-H: Horizontal distance between hamular to hamular notch; N: Number; Sd: Stander deviation; df: degree of freadum; Sig: Significancy.
**CONCLUSIONS**

Mean values of the all linear measurements were generally higher in the males compared with females and the significant sex differences in the means $P > 0.001$. The anatomical landmarks and measurement of artificial teeth showed slight mean difference and forward in position in relation to control group. The comfort percentage and successfulness of Prosthodontics treatment finding was higher in clinical cases without previous orthodontic treatment in relation to the second group.
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