Clinical application of Clear Aligner Treatment (CAT) in the Surgery-First Orthognathic Approach (SFOA)

Waddah Sabouni, Narayan H. Gandedkar, and Nikhilesh R. Vaid

Recent digital technological advancements in orthodontics have streamlined the surgery-first orthognathic approach (SFOA). Currently, it is established that simulation of complex surgical movements can be done digitally. However, there is lack of clarity on clinical protocols employed in Clear Aligner Treatment (CAT) for the management of Surgery-First Orthognathic Approach (SFOA). The primary objective of this article is to provide an, in-depth, answer to this question. This is a first-of-its-kind article that effectively utilizes clinical scenarios and case reports to meticulously describe the requirements of presurgical orthodontics, protocols during surgery, and post-surgery commencement of aligner-orthodontics in three dimensions (transverse,vertical and sagittal), along with clinical tips, dos, and don'ts. (Semin Orthod 2022; ■:1–13) ***© 2022 Elsevier Inc. All rights reserved.***

Introduction

Clear aligner treatment (CAT) is steadfastly growing to be an indispensable possibility, as an invisible modality of correcting malocclusions, especially in individuals who desire more than conventional way of correcting an orthodontic problem.[1,2] Additionally, individuals (generally adults) undergoing orthognathic jaw surgery are desiring for a speedy, clear, or invisible means of correcting their aberrant jaw and malocclusion problems.[3–6] Combination of CAT with surgery-first is poised to provide the answer. Although, amalgamation of CAT and SFOA could be an enticing opportunity for the Orthognathic-Jaw surgery practitioners (both Orthodontist and Surgeon),[7] there are no concrete guidelines (as far as our understanding) on how to progress, and what are the subsections, execution modalities (pre-surgical, during surgery, and post-surgery) that one need to follow to successfully execute a Surgery-First Orthognathic approach (SFOA) case.

Protocol for the Integration of Clear Aligner Treatment (CAT) in the management of Surgery-First Orthognathic approach (SFOA)

The following explains the step-by-step guidelines for the integration of CAT in the management of SFOA. SFOA and CAT integration fundamentally follows fours steps;

Step 1. Presurgical records collection

Step 2. Virtual Surgical Planning and ClinCheck ® evaluation of 'Surgical Jump'

Step 3. Surgery guides(s) fabrication, intermaxillary fixation (IMF) methods, ClinCheck for aligner fabrication, and special scenarios considerations

Step 4. Finishing and detailing, and retention regime planning

Step 1: Presurgical records collection

(Fig.1) Comprehensive records are collected including medical and dental history, 3D

Bandol Rivage, 2524 route de Bandol, 83110 Sanary-sur-Mer, France; Senior Lecturer, Discipline of Orthodontics, Faculty of Dentistry, The University of Sydney School of Dentistry, Faculty of Medicine and Health, Sydney Dental Hospital, Sydney Local Health District, Australia; Adjunct Professor, Department of Orthodontics, Saveetha Dental College, Saveetha Institute of Medical and Technical sciences, Chennai 600077, India.

Corresponding author. E-mail: orthonik@gmail.com

1073-8746/12/1801-$30.00/0

https://doi.org/10.1053/j.sodo.2022.12.002

radiographs of maxillo-mandibular skeletal structure (Cone beam computed tomography, CBCT), and intraoral scans (iTero® intraoral scanner) for the diagnosis and treatment planning. At this stage, either the Orthodontist or the Surgeon work in-silo or coordinate with each other for the efficient collection of the records. Irrespective of working in-silo or collaboratively, the primary focus of the stage 1 is to prepare the multidisciplinary team (Orthodontist and Surgeon) focus on the successful execution of a surgical treatment protocol, based on the chief complaint of the patient, by means of virtual surgical planning (VSP) and a ClinCheck ®.

Step 2: Virtual surgical planning and ClinCheck ® evaluation of 'Surgical Jump'

(Figs.1-3) Once the records are collected, treatment planning is executed based on a problem list revealed from the presurgical records. A surgical simulation (VSP) is done using a 3D analysis software (for e.g., Dolphin imaging ®, Exocad®, or any 3D model analysis software) in concordance with a proprietary digital treatment planning software ClinCheck ® (digital treatment planner) from clear aligner manufacturer (Align Technology, San Jose, California). The VSP, done via 3D analysis software, allows the simulation of 'final occlusion' which could be achieved post-surgery. Subsequently, the 'final occlusion' is synchronised in to ClinCheck® to make compensatory modifications termed as 'Surgical Jump'. A 'surgical jump' aids in not only visualisation, but also, ascertains evaluation of 'Occlusal Interferences' in all three dimensions. Therefore, the primary objectives of visualising or pre-viewing a surgical jump, in the beginning itself, is a pre-requisite of incorporating CAT in SFOA, as it (1) identifies the feasibility of performing surgery-first or (2) whether the case requires any presurgical decompensation, and subsequently (3) assist in the fabrication surgical guides or bite wafers using ClinCheck® (a detailed description of 'Surgical Jump' is provided in the case presentation).[8]

At least, four different scenarios exist during the 'Surgical Jump' phase, and they are (Fig. 4).

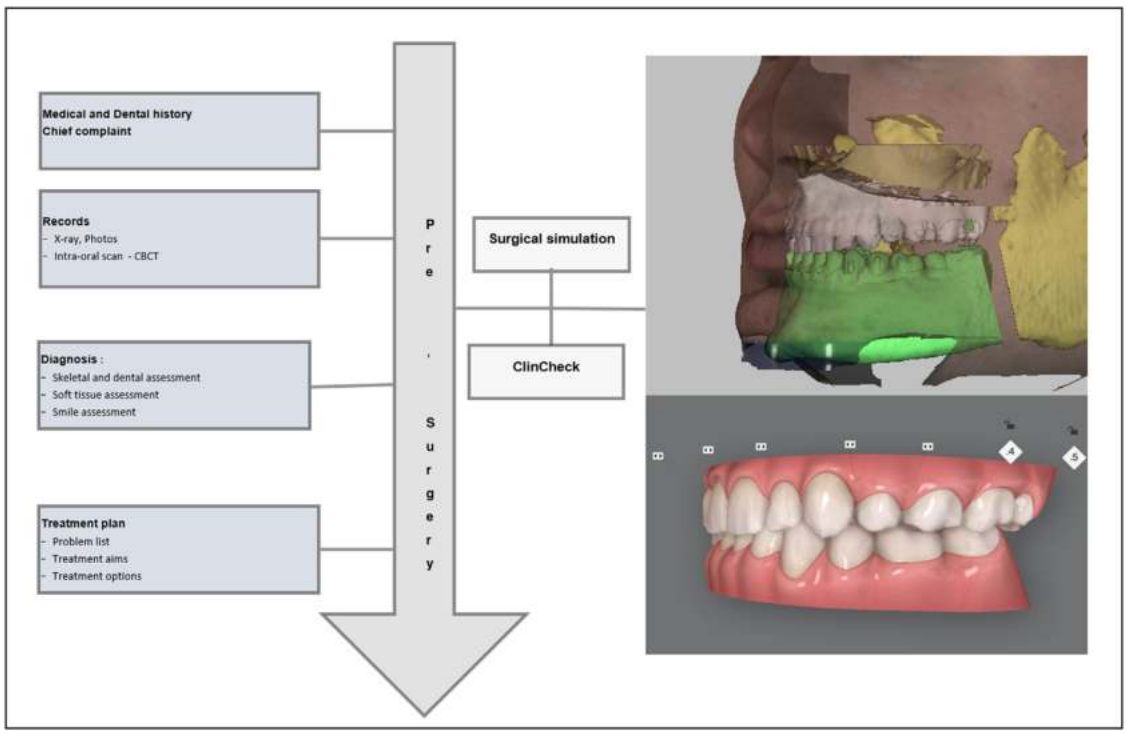

Fig. 1. A thorough pre-treatment records is a pre-requisite for successful management of SFOA case.

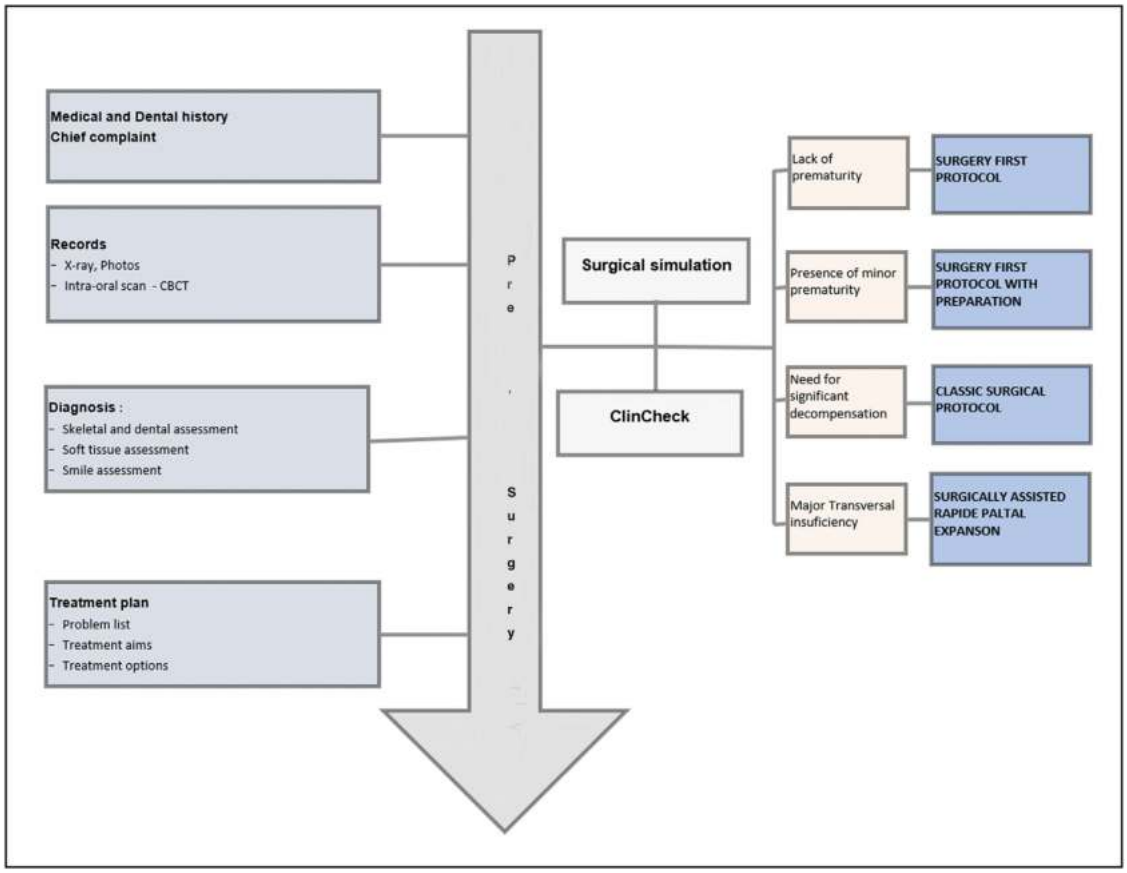

Fig. 2. Surgical simulation and ClinCheck will lead to four different possibilities.

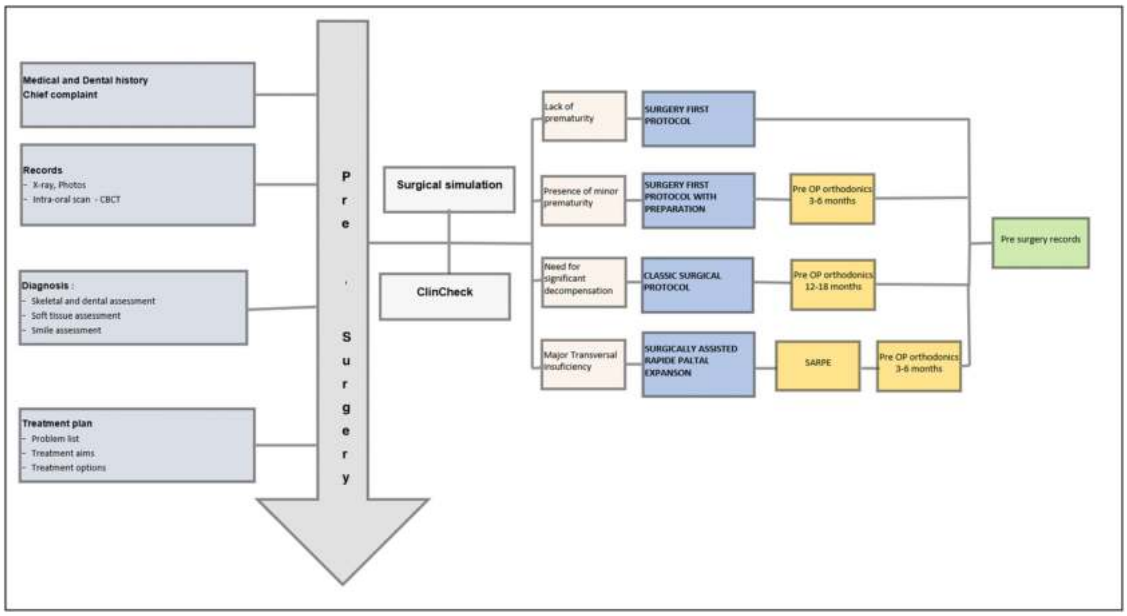

Fig. 3. Based on the four different possibilities, the pre-surgical preparation time is determined.

Fig. 4. Surgical Bite Jump: leveling and aligning of upper anterior teeth, especially, upper right central incisor (top row) will be carried out as a part of pre-surgical preparation. Middle row showing power-ridge used as an attachment for proclination or uprighting of upper right central incisor, and bite-turbo on the lingual surfaces of upper lateral incisors to ensure three-point landing. The bottom row showing passive aligners prepared for surgery with programming of precision button cut outs into the aligners.

Scenario 1 Absence of occlusal prematurity – minor or no crowding. In this scenario there are virtually no occlusal interferences in all three dimensions, and a three-point landing is achievable. These cases are ideally suitable for surgery-first approach with no preparation (for e.g., no translation movement of teeth, flat or normal curve of Spee, no palatal cusp hanging etc.,).

Scenario 2 Presence of occlusal prematurity –minor occlusal interference with lack of three-point landing. This scenario requires short pre-surgical preparation time (on an average it takes about less than 6 months) prior to performing surgery-first (for e.g., correction or up righting of teeth, limited dental arch movements etc.,)

Scenario 3 Presence of severe transverse discrepancy – This scenario requires addressing the severe transverse skeletal problem prior to surgery-first. For example, if the patient has more than six millimetres of skeletal transverse discrepancy, it should be addressed by surgically assisted palatal expansion (SARPE) before-hand. Post transverse problem correction surgery-first can be performed.

Scenario 4 Presence of significant interference – major dental decompensation is

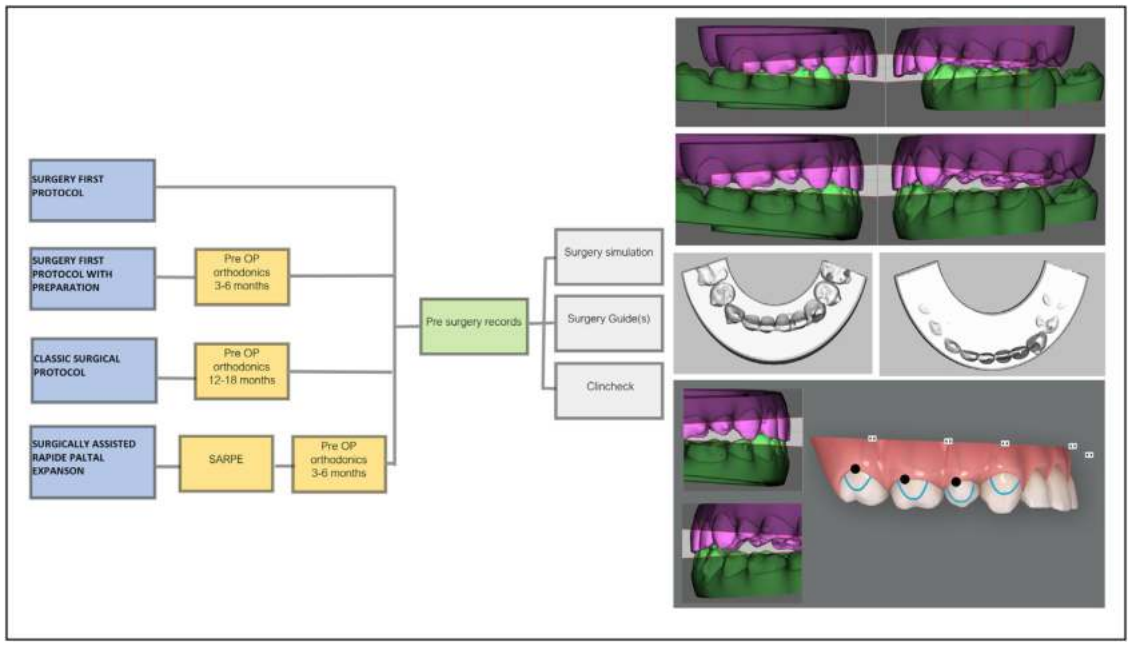

Fig. 5. Flow chart depicting the surgical bite jump for the fabrication of surgical bite wafers, and ClinCheck model showing precision button cut outs.

required. This scenario is not suitable for surgery-first due to poor clinical predictability and might be challenging for the biomechanically inept third-party technician to accommodate complex tooth movements. Hence, should follow the conventional jaw surgery approach of performing full decompensation during pre-surgical phase. For e.g., correction of all three-dimensional discrepancies with rotational movement adjustment (Pitch. Roll, and Yaw).The importance of determining these scenarios is manifold, and they are, it allows the categorization of type of Surgery, it provides a preview to pre-surgical preparation time, and it takes into consideration of any additional transverse relation correction required prior to jaw-surgery (for e.g., surgically assisted rapid palatal expansion, SARPE) (Fig. 3).

Step 3: Surgery guides(s) fabrication, intermaxillary fixation (IMF) methods, ClinCheck for aligner tray fabrication, and special scenarios considerations. (Figs.5 and 6)

The surgical splints are 3D-printed based on the final occlusion obtained by the VSP. The number of surgical splints depend on the type of surgery and surgeons' preference, which typically corresponds to one final wafer for single jaw surgery, and two (intermediate and final) for double jaw surgery. Further, in this step, intermaxillary fixation (IMF) technique is decided based on the anchorage requirement during the surgery phase. Some of the options to secure IMF and the clinical reasoning is explained here, (Fig. 6)

1) Mini-screw and stainless-steel ligatures to secure surgical wafers if surgical wafers are preferred to be used for stabilizing the post-surgical bony segments, and occlusion.

2) A combination of bondable buttons on the teeth and miniscrew for the application of elastic bands with no surgical wafer is preferred if it is decided to retain the surgical movements with the assistance of miniscrews and elastic bands.

3) Using only aligner trays with precision cut-outs and bondable metallic buttons on all buccal dentition for application of elastic bands. The metallic buttons are recommended as they are radiopaque and can be easily located and retrieved should a situation of button

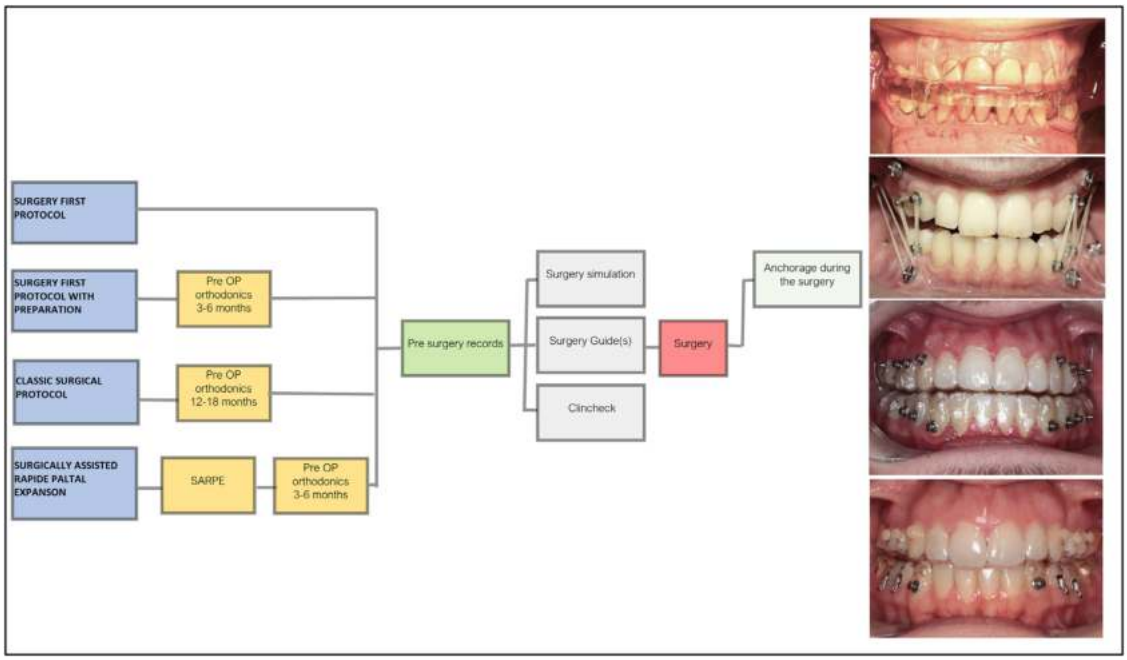

Fig. 6. Intermaxillary fixation (IMF) technique is based on the anchorage requirement during the surgery phase. The authors recommend the application of aligners with precision button cut outs.

debonding and dislodging arise. This is the preferred method of stabilization of post-surgical occlusion as the aligners act as surgical bite wafers and, hence, aid in the retention of the correction.

The Simulation models are uploaded to the Clin Check in order to fabricate aligners post surgery as well using the surgical virtual jump. The 10 passive aligners fabricated during surgical the peri-surgical phase are fabricated with the intial lot of pre surgical aligners. As many as ten passive aligners are provided to the patient so that they don't miss out on the full wear time should the aligners are lost or go missing for some reasons. The patient is advised to wear the passive aligners prior to one week before surgery, and the same passive aligners are worn for the subsequent two weeks following post-surgery in combination with elastic bands. Therefore, in total, the patient wears the passive aligners for three weeks. It is imperative to emphasise the fact that the patient wears the aligners all the time, and the elastic bands, if any, are indicated, as there are significant chances of uncontrolled tooth movement due to the inducement of regional acceleratory phenomenon (RAP), if the patient does not wear the aligners. In general, post-surgically, the patient is encouraged to wear the aligner and elastic bands as soon as possible, preferably, within two days of surgery.

Additionally, in this stage itself, in special case scenarios such as stabilization of transverse expansion, several ways are indicated to stabilize the transverse correction, and they are, (1) maintenance of bone-borne expander as retention appliance, (2) application of trans palatal arch, or (3) bonding of 3D-printed bondable palatal expander (Fig. 7).

Step 4: Finishing and detailing, and retention regime planning. (Fig. 8)

The post-surgical phase, typically, is carried-out for six-months. ClinCheck® software is judiciously used to simulate remaining tooth movement to achieve the final tooth position. The post surgical aligners are fabricated on the basis of the scan done before surgery. The surgical simulation approved on the Clin Check software determines this fabrication. The orthodontist visually reviews the predicted progress as well as the finishing set

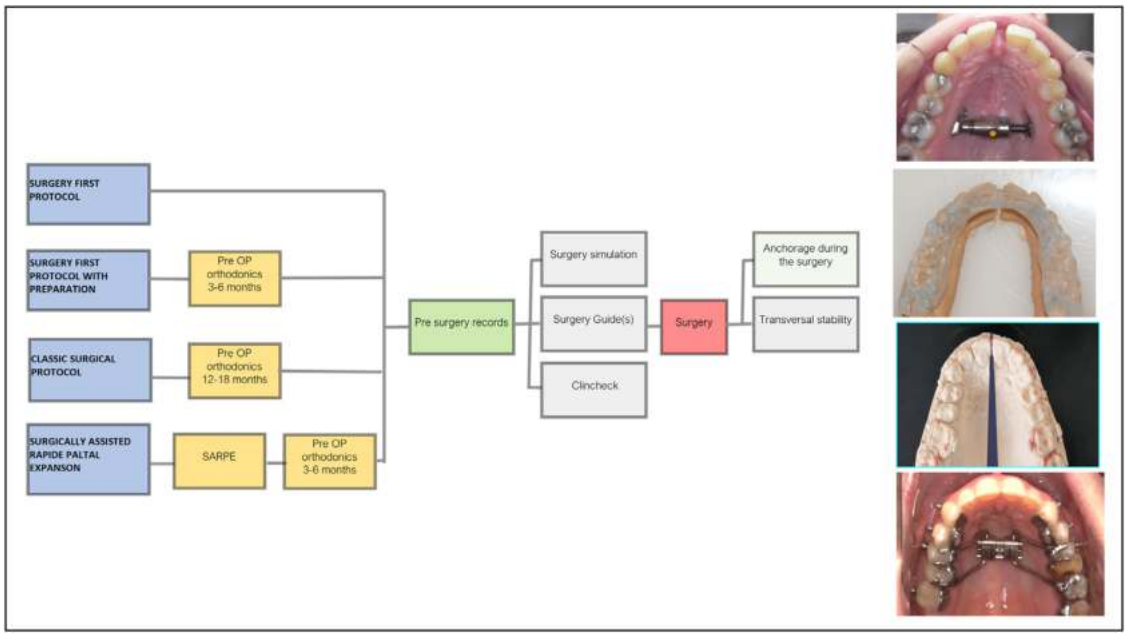

Fig. 7. Stabilization of transverse expansion: several ways are indicated to stabilize the transverse correction.

up in three dimensions. Further requests can be made using ClinCheck ® software to modify any treatment plan to suit to the individuals finishing and detailing obligation, such as, Bolton discrepancy resolution, performing interproximal reduction (IPR), creation of space as a part of comprehensive oral rehabilitation (for e.g., prosthodontic implants placement, restoration of peg laterals and so on).[8–10] Also, the Refinement scans can be made for additional aligners to improve finish and detailing. Retention protocol employed is a clear thermoplastic retainer worn every night for the first year,every other night in the second year, and one night a week from the third year onwards. The regimen to be followed after the third year is lifetime (Fig.9).

Case presentation (Figs. 10-16)

To summarise the application of the above-mentioned protocol, we present a case study.

A 25-year-old female presented with the chief complaint that 'she does not like her upper front teeth and her chin is small'. Initial photographs showed Class II Division 1 malocclusion having a deep-bite, maxillary occlusal plane canting, and retroclination of upper right central incisor. She had a history of previous orthodontic treatment. The primary goal of orthodontic treatment was resolution of chief complaint and achievement of aesthetically balanced face with Class I molar relation and normal overjet and overbite. A combination of Orthognathic surgery (mandibular advancement surgery alone) and clear aligner treatment was advised to resolve the malocclusion and to achieve the primary goal of treatment (Figs.10 and 11).

The case represents scenario 2 (as explained in Step 2) which has occlusal prematurity −minor occlusal interference with lack of three-point landing. This scenario requires short pre-surgical preparation time (on an average it takes about less than 6 months) prior to doing surgery-first. In this case, a 'Surgical Bite Jump', at the beginning, is not possible due to the presence of occlusal prematurity in the form of retroclination of upper right central incisor, and hence lack of three-point landing. Therefore, leveling and aligning of upper anterior teeth, especially, upper right central incisor will be carried out as a part of pre-surgical preparation. Miniscrew was used to actively intrude the upper right central incisor along with aligners for leveling and aligning (Fig. 12). The power

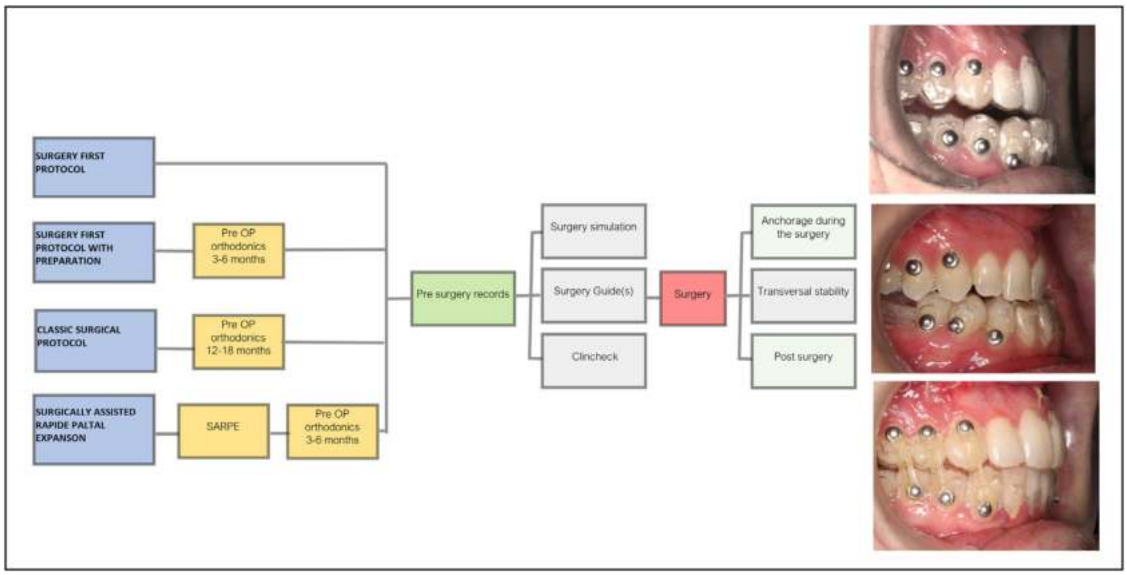

Fig. 8. Passive aligners prepared for surgery.

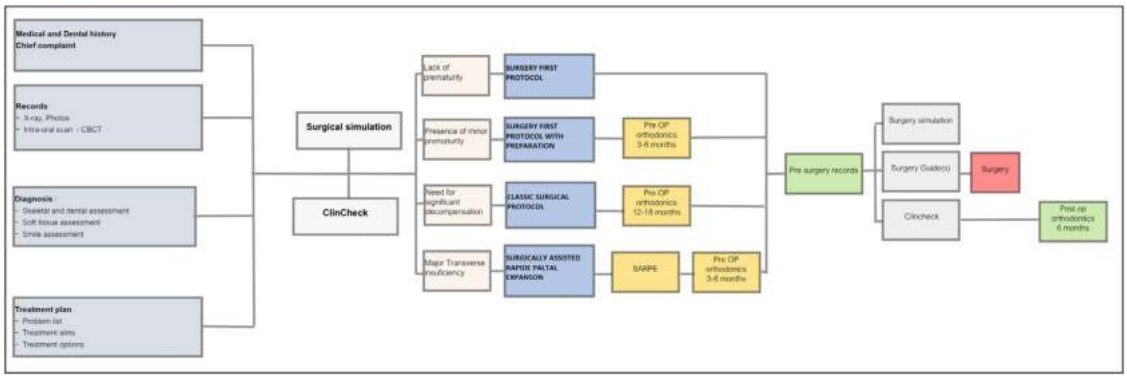

Fig. 9. Complete protocol for the integration of Clear Aligner Treatment (CAT) in the management of Surgery-First Orthognathic approach (SFOA).

ridge was used as an attachment for proclination or uprighting of upper right central incisor, and bite-turbo on the lingual surfaces of upper lateral incisors to ensure three-point landing. Also, passive aligners were prepared for surgery with programming of precision button cut outs into the aligners.

Correspondingly, Class III elastics were used for the decompensation. After twenty-four aligners and six months from the start of the treatment, the objective of pre-surgical phase was fulfilled, and she was ready for mandibular advancement surgery. The precision button cut outs were bonded onto the buccal teeth. Bite-turbo on the lingual surfaces of upper lateral incisors were bonded for the three-point landing, and the simulation was performed on the 3D-printed study models for the surgical bite wafer fabrication. (Fig. 13) A bilateral sagittal split osteotomy was performed for the advancement of the mandible. Also, post-surgical phase aligners were requested to fabricate based on the ClinCheck simulation. (Fig. 14) The post-surgical phase lasted for 6-months.

Twelve months was the total treatment time required from the start to finish with fulfilment

Fig. 10. Initial photographs of a 25-year-old female with Class II Division 1 malocclusion having a deep-bite, maxillary occlusal plane canting, and retroclination of upper right central incisor.

of treatment objectives. The planned retention regime was two years of night time wear of clear Vivera retainers with constant follow ups and remote monitoring using a virtual care application.

Conclusion

The article describes the protocol and guidelines for the Integration of Clear Aligner Treatment (CAT) in the management of Surgery-First Orthognathic approach (SFOA). The advantage of using this protocol and following the guidelines as described are, in terms of patient (1) decreased duration of pre-surgical phase, (2) efficient utilization of regional acceleratory phenomenon (RAP) thereby faster orthodontic tooth movement, (3) decreases duration of post-surgical phase, and hence, leads to (4) enhanced patient satisfaction, and experience.[2,8,9,11–14]

Further, the advantage of the protocol in regards to clinician is that it envisages novel perspective in providing the diagnosis and development of treatment plan that complement the orthodontist and the surgeon, (1) before treatment (2) during the treatment, and (3) enhance

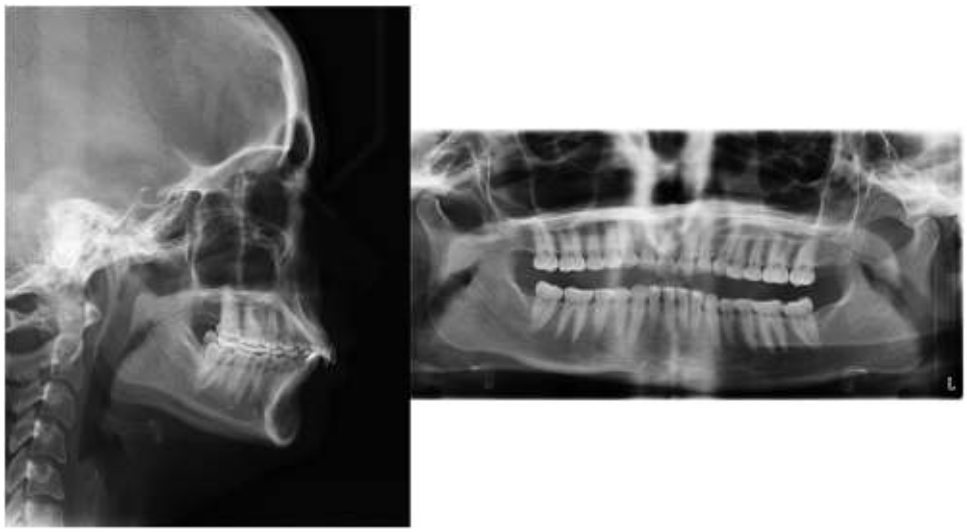

Fig. 11. Initial lateral cephalograph and orthopantomograph radiograph.

Fig. 12. Figure depicting (top row) during the leveling and alignment phase where a miniscrew was used to intrude and procline the upper right central incisor along with aligners. Also, Class III elastics were used for the decompensation. After twenty-four aligners (Six months from the start of the treatment) the objective of pre-surgical phase is fulfilled and is ready for mandibular advancement surgery (bottom row).

inter-personal communication between patient and clinician.[15] Leveraging these advantages with CATs merits such as, (1) better maintenance of oral hygiene in comparison to conventional fixed appliance., (2) fewer appotinemnt, and (3) less chair side time, makes the combination of SFOA and CAT a great modality of treatment option as far as orthognathic-jaw surgery patients that demand invisible and speedy form of treatment. [14]

Fig. 13. Preparation for Surgery: (Top two rows) precision button cut outs were bonded onto the buccal teeth. Bite-turbo on the lingual surfaces of upper lateral incisors were bonded for the three-point landing. The simulation was performed on the 3D-printed study models for the surgical bite wafer fabrication (middle row). Also, post-surgical phase aligners were requested to fabricate based on the ClinCheck simulation (bottom row).

Fig. 14. Post-surgery phase: patient is wearing the aligners along with settling elastics.

Fig. 15. Post-treatment photographs showing fulfillment of treatment objectives.

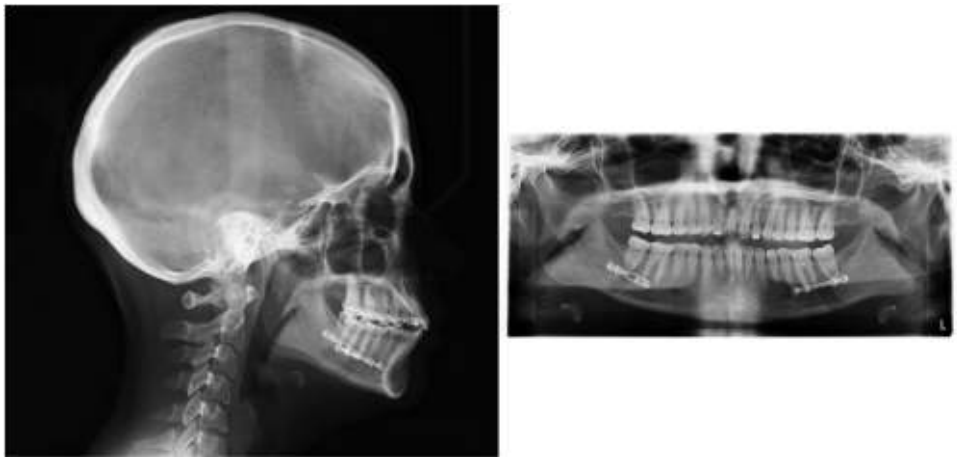

Fig. 16. Post-treatment lateral cephalograph and orthopantomograph showing fulfillment of treatment objectives.

References

1 Adel SM, Vaid NR, El-Harouni N, Kassem H, Zaher AR. TIP, TORQUE & ROTATIONS: how accurately do digital superimposition software packages quantify tooth movement? *Prog Orthod*. 2022;23:1–10.

2 Al-Nadawi M, Kravitz ND, Hansa I, Makki L, Ferguson DJ, Vaid NR. Effect of clear aligner wear protocol on the efficacy of tooth movement: a randomized clinical trial. *Angle Orthod*. 2021;91:157–163.

3 Chng CK, Gandedkar NH, Liou EJ. *Diagnosis and Treatment Planning of Surgery-First Orthognathic Approach Surgery-First Orthodontic Management*. Springer; 2019:7–14.

4 Chng CK, Gandedkar NH, Liou EJ. *Surgery-First Orthognathic Approach Treatment Protocol: Orthodontic Considerations Surgery-First Orthodontic Management*. Springer; 2019:37–50.

5 Gandedkar NH, Vaid NR, Darendeliler MA, Premjani P, Ferguson DJ. *The Last Decade in Orthodontics: A Scoping Review Of The Hits, Misses And The Near Misses! Seminars in*. Orthodontics: Elsevier; 2019:339–355.

6 Kankam H, Madari S, Sawh-Martinez R, Bruckman KC, Steinbacher DM. Comparing outcomes in orthognathic surgery using clear aligners versus conventional fixed appliances. *J Craniofac Surg*. 2019;30:1488–1491.

7 Sabouni W, Lacroix M, Leclercq P, Des Georges O. Traitement orthognathique et aligneurs, quel protocole? *Orthod Française*. 2021;92.

8 Moshiri M. Considerations for treatment of patients undergoing orthognathic surgery using clear aligners. *AJO-DO Clin Companion*. 2022.

9 Vaid N. Lets talk ALIGNers! APOS. *Trends Orthod*. 2016;6:177-177.

10 Naung NY, Van Sickels JE, Hartsock TE, Sword JL. Orthognathic surgery in a patient with clear aligners and veneers: options for interim fixation and early elastic physiotherapy—case report. *Craniomaxillofacial Trauma Reconstr Open*. 2020;5: 2472751220949405.

11 Hansa I, Katyal V, Ferguson DJ, Vaid N. Outcomes of clear aligner treatment with and without dental monitoring: a retrospective cohort study. *Am J Orthod Dentofacial Orthop*. 2021;159:453–459.

12 Hansa I, Semaan SJ, Vaid NR. Clinical outcomes and patient perspectives of Dental Monitoring® GoLive® with Invisalign®—a retrospective cohort study. *Prog Orthod*. 2020;21:1–7.

13 Haouili N, Kravitz ND, Vaid NR, Ferguson DJ, Makki L. Has Invisalign improved? A prospective follow-up study on the efficacy of tooth movement with Invisalign. *Am J Orthod Dentofacial Orthop*. 2020;158:420–425.

14 Vaid NR, Sabouni W, Wilmes B, Bichu YM, Thakkar DP, Adel SM. Customized adjuncts with clear aligner therapy:"The Golden Circle Model" explained!. *J World Federation Orthod*. 2022.

15 Gandedkar NH, Dávila MMC, Chng CK, Liou EJ, Darendeliler A. Surgery-first orthognathic approach: A "scoping review" for mapping outcomes and plausible recommendations to develop core outcome sets. *APOS Trends Orthod*. 2019;9:77–88.