

**Zirkonzahn®**

*Human Zirconium Technology*



## HIGH EFFICIENCY THROUGH SPLINT THERAPY

*Restoring patient's full functionality thanks to interdisciplinary cooperation*



## DENTAL TECHNICAL ANALYSIS AND DIAGNOSTICS

*Working steps for dental technical analysis and diagnostics are based on close consultation with the dentist. These are dental technical procedures that can be carried out in addition to dental diagnostics. Focus is on gathering important dental technical information for the creation of dental prostheses.*

*Dental technical analysis and diagnostics are among the most creative activities in dental prosthetics. Dental technical expertise represents an essential part of the planning process. However, in order to obtain a realistic diagnostics assessment, the treatment planning must be physically verified and tried out by the interested patient (try-in teeth). This is the only way to get patient-specific information such as oral situation and possible dimensional changes for the denture.*

*Just as a reminder: most of the sensory organs are located in and around the mouth region, especially the tactile ability of the tongue tip to the upper central incisors. This region perceives a difference of 3  $\mu$ !*

*With the model transfer by means of the PlaneSystem®, a realistic position of the aesthetic and functional planes of the upper jaw model in the articulator can be achieved, improving the communication between dental technician, articulator and model for the production of patient-oriented restorations. In combination with the physical analysis of face, speech, model and denture, all information which makes a patient-oriented prosthesis possible, is obtained.*

*Dr. Siegfried Marquardt, MDT Udo Plaster and physiotherapist Ralf Hergenroether*



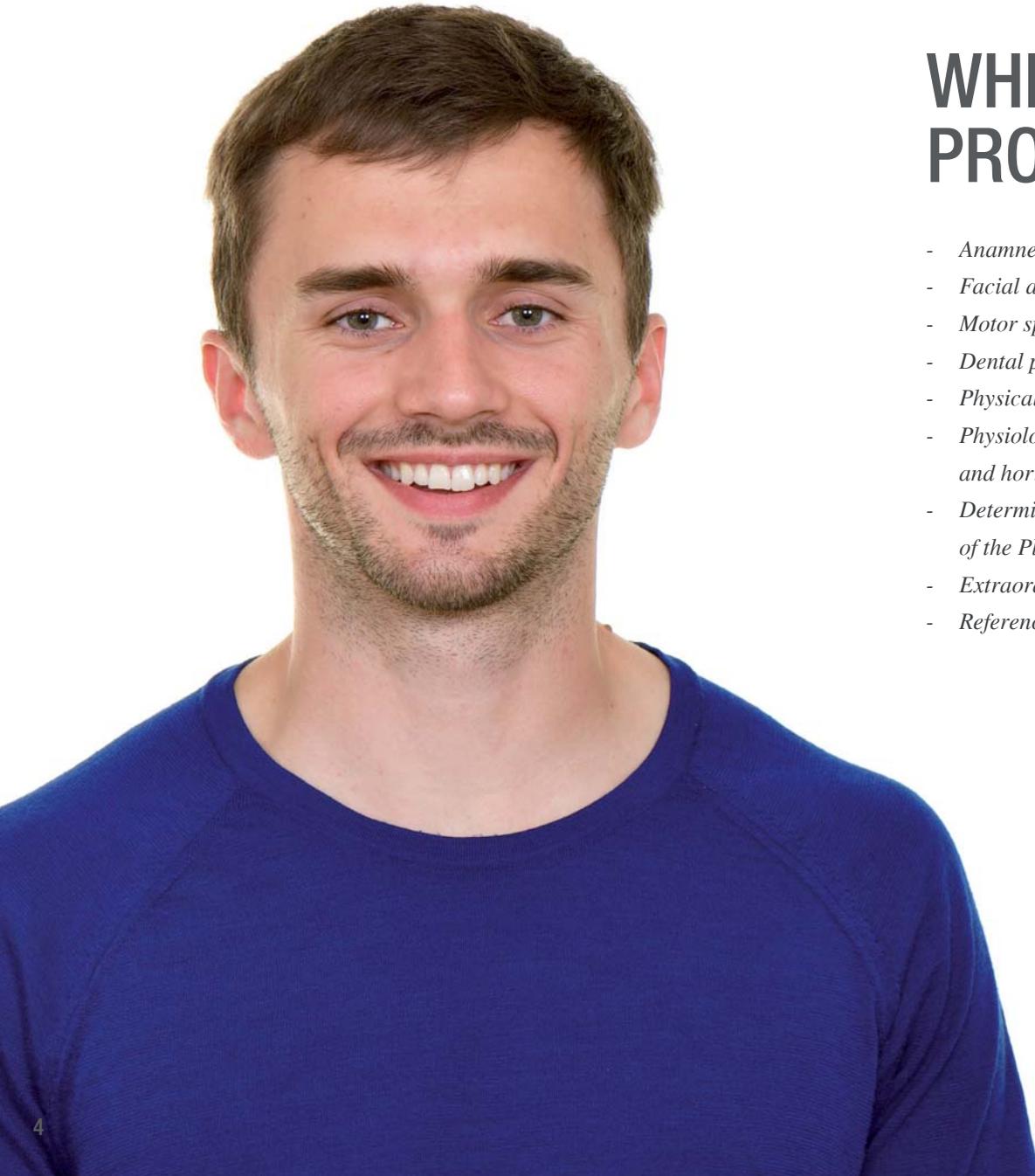
# AIM OF SPLINT THERAPY

*Splint therapy is usually used to restore patient's dysfunction (final position) into a stable position (starting position) and to reduce or eliminate physical discomfort (Plaster et al., 2020). However, not all splints are the same.*

*For a successful improvement of patient's discomfort, precise all-embracing analysis and anamnesis are necessary. Body should be considered as a dynamic system and included as a whole in the diagnosis, taking into account muscular and neuromuscular aspects. In the human organism there are no isolated body parts or cells, i.e. all disorders (e.g. teeth, active scars, chronic inflammations) occurring in certain organism areas affect other organs and/or vice versa. Three main areas are recognised:*

- *biophysical level (skin, bones, teeth, nerves, etc.),*
- *biochemical level (body and cell fluids, metabolic system, etc.),*
- *bioenergetic level (electrical impulses at cellular level, electromagnetism, energy fields, etc.).*

*Physiotherapists diagnose the causative parameters on biophysical level purely mechanically (Marquardt et al., 2021).*



## WHICH IS THE PROCEDURE?

- *Anamnesis – Dental history*
- *Facial and model analysis*
- *Motor speech function test*
- *Dental prosthesis analysis*
- *Physical set-up and mock-up*
- *Physiological and perceptual determination of centre, height and horizontal position of the lower jaw in relation to the skull*
- *Determination of the patient's upper jaw position by means of the PlaneFinder®*
- *Extraoral pictures, video and face scan documentation*
- *Referenced transfer of the information into a 3D articulator*

## ANAMNESIS – DENTAL HISTORY

*The young professional athlete suddenly suffered from joint and muscle pain during his training sessions. He also reported he couldn't train for a whole week without pain.*

*At the age of 14, he started a physiotherapeutic and orthopaedic treatment for a pelvic-shoulder misalignment and scoliosis (three-dimensional curvature of the spine).*

*During the preparatory training for the Bavarian Championships 2020, the patient met the physiotherapist Ralf Hergenroether who treated him for inflamed groin, hardened calves and joint pain. During treatments, the physiotherapist examined the patient from head to toe and found out that the higher the load during training, the more the same symptoms and problems in muscles and joints occurred. He suspected the discomfort could be caused by the jaw. With patient's agreement and for a comprehensive analysis, he consulted the dentist Dr. Siegfried Marquardt and the dental technician Udo Plaster.*

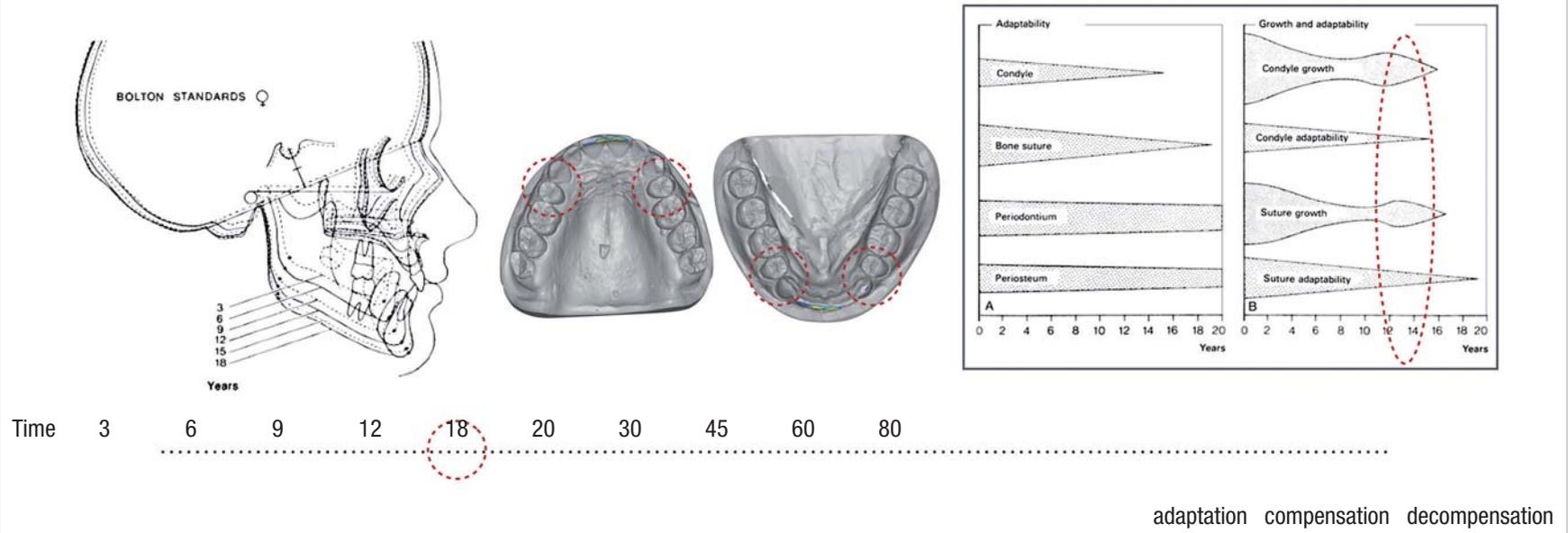
*While gathering information, it also turned out that the patient had been undergoing orthodontic treatment for many years due to a premolars extraction which involved two premolars in the upper and lower jaw. Due to*

*the extraction, the teeth newly displaced in the jaw and the lower jaw also compacted slightly dorsally. As a result, the patient's system had to compensate early on.*



*Physiotherapy treatment: head rotation test to the left and right, showing a clear difference between the two movements. Head rotation was generally difficult for the patient. The different tests revealed that the patient had both an ascending chain (due to the injuries already described) and a descending chain (due to a lack of contact in the posterior region).*

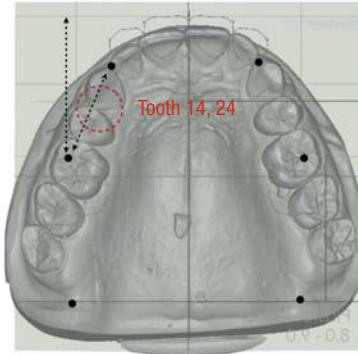
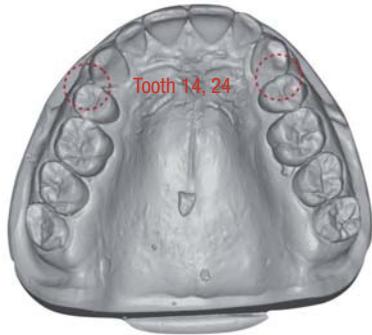
Anamnesis – Dental history  
 Facial and model analysis



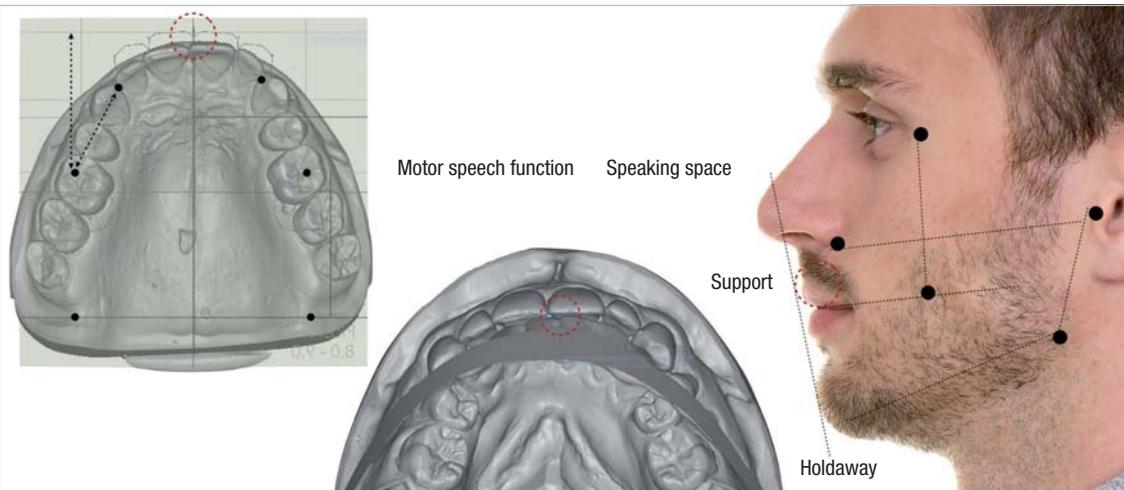
## FACIAL AND MODEL ANALYSIS

*Left: the relationship between the six-year molar, incisors and growth phase, arranged in a timeline. Right: interrelationship between growth and adaptation. Up to the age of 14/15, the system can well adapt to changes. When performing surgery on the human body, care must always be taken to ensure that these changes function properly, as the human being can only compensate to a certain extent. Since the patient is a professional athlete and his body is exposed to high stresses, a decompensation occurred in his system (descending chain). Under these circumstances, the treatment with the physiotherapist Ralf Hergenroether began.*

Anamnesis – Dental history  
 Facial and model analysis



*Due to premolars extraction which the patient's system could not adapt optimally, teeth were displaced in the jaw. The Plaster Plane clearly showed that this factor reduced the size of the growth area and of the entire dental arch (incisors).*



*The red marks indicate an aesthetic deficit caused by the shaping of the dental arch (support of the mimic musculature in the upper lip. This narrowness affected the speaking space as well as the motor speech function).*

## PHYSIOLOGICAL AND PERCEPTUAL DETERMINATION OF CENTRE, HEIGHT AND HORIZONTAL POSITION OF THE LOWER JAW IN RELATION TO THE SKULL

After model and facial analysis, the centre, height and horizontal position of the lower jaw in relation to the skull were determined perceptually and physiologically (patient's alignment without exogenous influences, e.g. sitting, headrest, etc.). It turned out that patient had height deficits in the posterior region. When evaluating the lower jaw centre in relation to the skull centre, it turned out that the lower jaw moved backwards to the right (patient's side view). On the horizontal plane, the lower jaw moved upwards to the back.



liiii.



Sssss.



Eeeee.

Physiological and perceptual determination of **centre**, **height** and **horizontal position** of the lower jaw in relation to the skull

Model analysis

Motor speech function

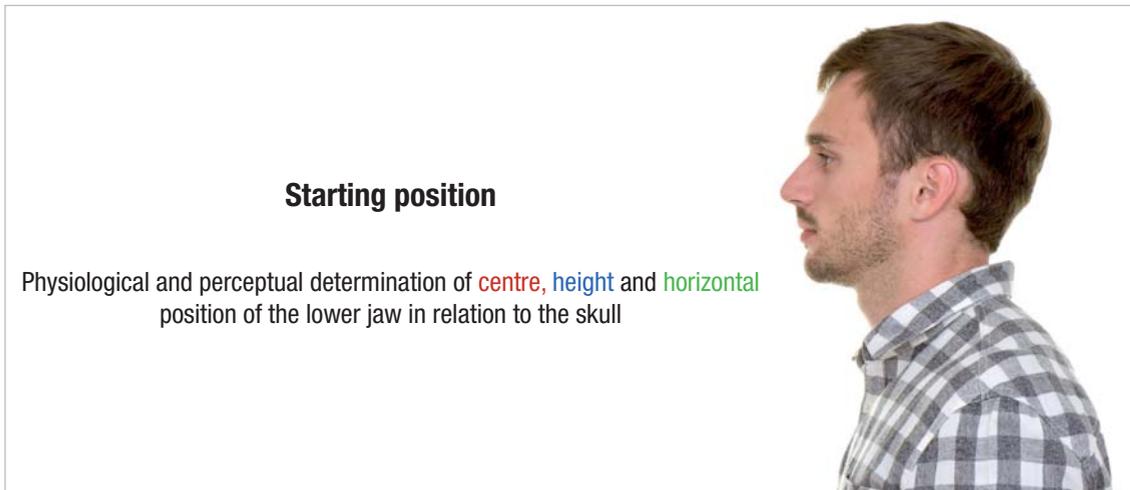
Holdaway

Facial analysis

Left: lower jaw centre in relation to the skull as well as missing occlusal height in the posterior region. Middle: when testing the speech motor function, it turned out that the patient's tongue was trying to compensate for the lack of contact in the posterior region. Right: display of holdaway line, anatomical landmarks of growth and position of the six-year molar in relation to os zygomaticum (point below eye), ala-tragus and jaw angle.



*Impressions which make all anatomical points visible; acquisition of the lower jaw position and PlaneFinder® registration.*



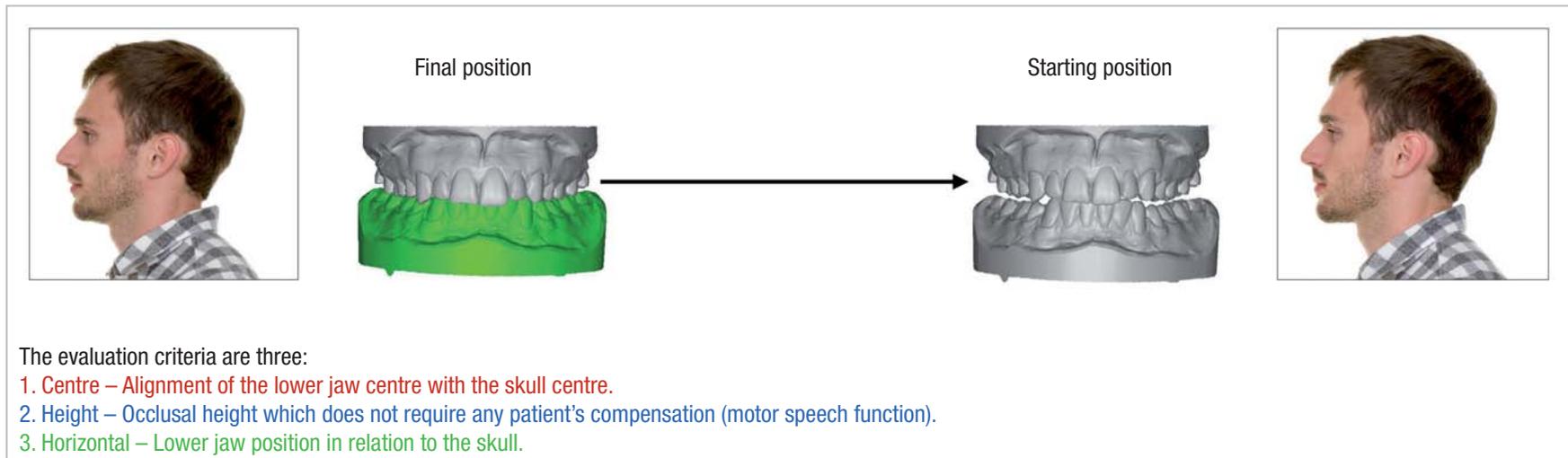
*Before carry out a registration, the techno-clinical team has to consider the patient history as well as centre, height and horizontal position of the lower jaw in relation to the skull.*

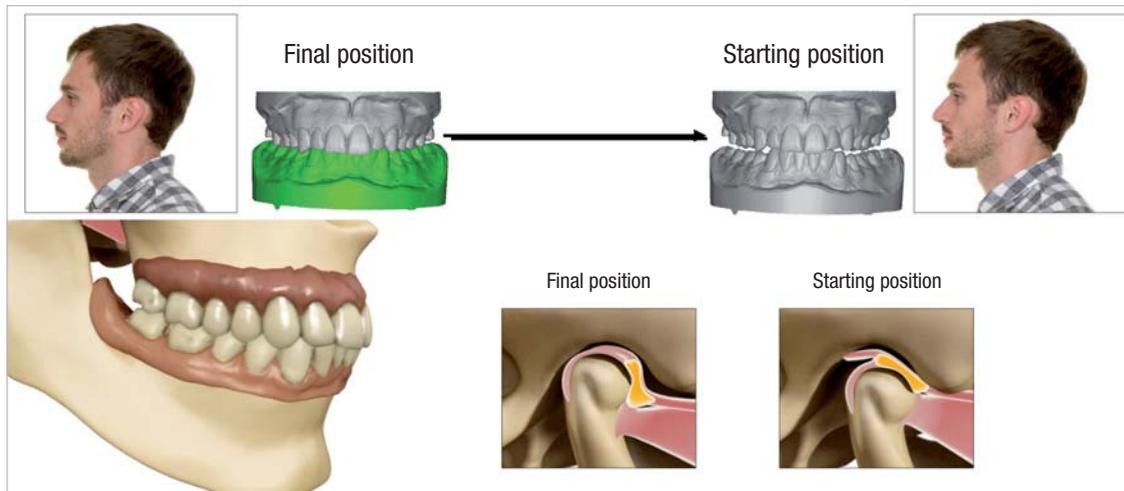
## FINAL AND STARTING POSITION

The starting and final positions refer to the position of the lower jaw in relation to the skull. In the starting position (zero point), the body is stable and harmoniously aligned and can optimally apply and balance forces. Whereas in the final position, the body is unbalanced due to endogenous or exogenous influences. In this condition, the body tries to compensate for the imbalance (e.g. misalignment), leading to possible organic, muscular or skeletal problems.

Causes which can lead to a body imbalance are divided into ascending and descending rotational chains. A combination of both can also occur. In case of ascending rotational chain, shoulder girdle, upper cervical joints and jaw joints compensate for the malfunctions in the lower body part, e.g. injuries in the foot region. In case of descending rotational chain, the dysfunction affects the cervical and temporomandibular joints (e.g. CMD). For athletes, a good starting position is essential for retrieving optimal strength performance.

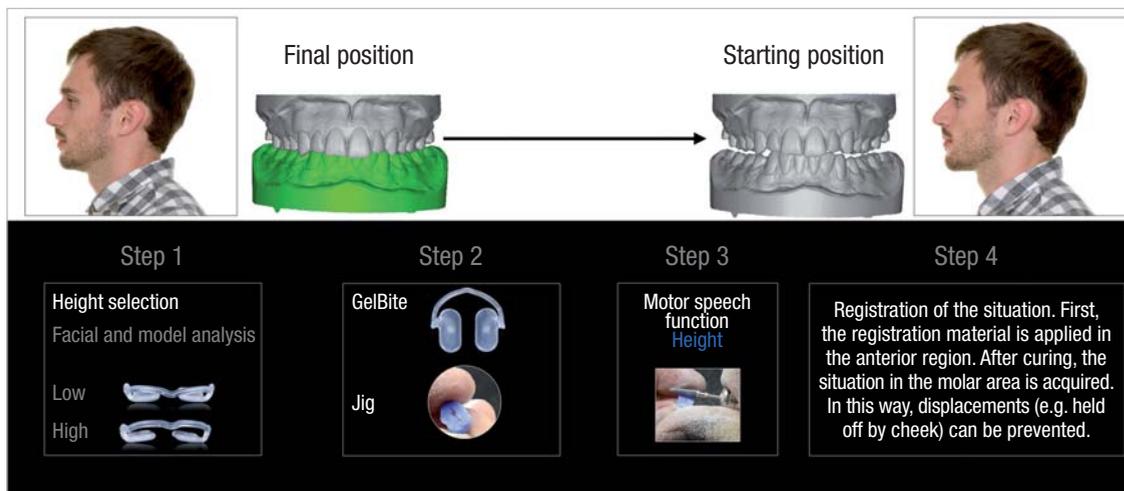
If the final position is far from the starting one, the body has to work hard to keep the human system stable (Plaster et al., 2020). Before carry out a registration for later splint production, it is therefore really important that the techno-clinical team is aware of the centre, height and horizontal position of the lower jaw in relation to the skull.





Watch the video

*Rotational and sliding movements of the lower jaw in the starting and final positions.*



1. Selection of the appropriate GelBite and Aqualizer (water pads), to relieve and restore the system functional balance.
2. Jig creation with Aqualizer or GelBite, followed by finishing and smoothing the Jig surface.
3. Jig insertion and removal of the GelBite from the patient's mouth. Height definition and adjustment of motor speech function.
4. After adjustment and lower jaw reproducible acquisition, registration material is applied.



Final position

Starting position

Step 1 Test of the vertical dimension with GelBite (Aqualizer) and Jig

Step 2 Control of the vertical dimension without GelBite (Aqualizer) but with Jig

Step 3 Test of the lower jaw central relation without manipulation

Step 4 Occlusion – frontal/lateral determination

*If all these steps are followed, a wrong occlusion acquisition can be excluded.*



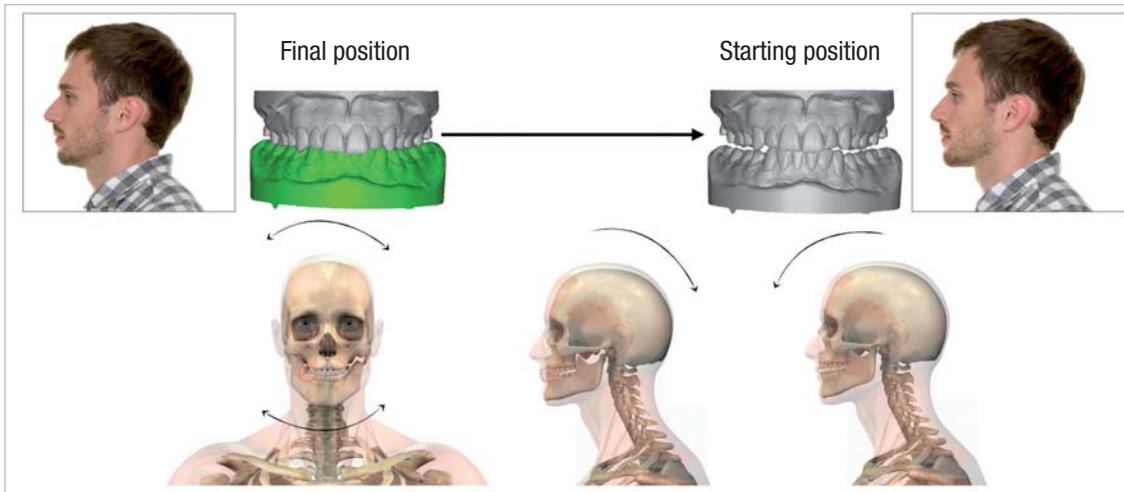
Final position

Starting position

**Preparation of the occlusion acquisition**

Is it an ascending or descending rotational chain?

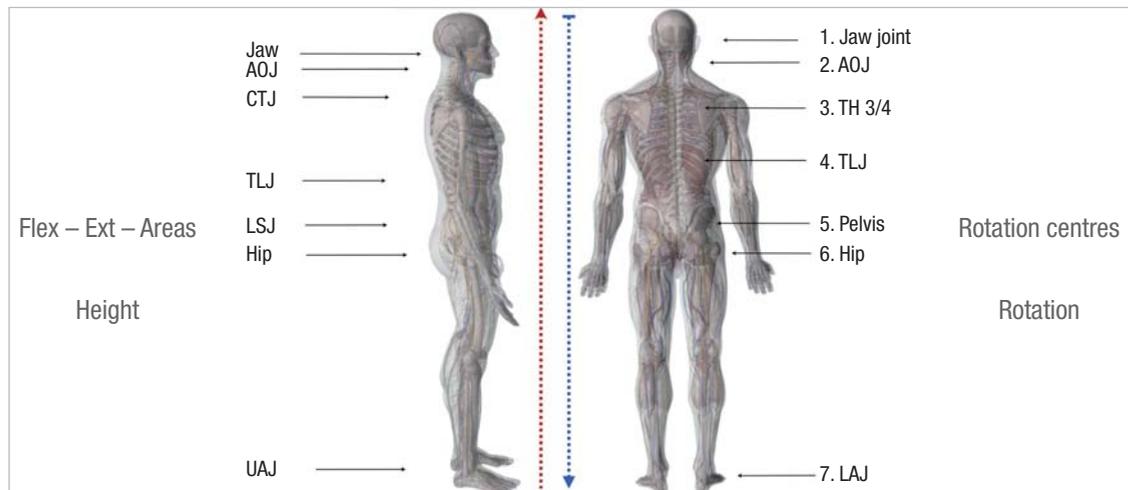
*Patient's system compensation and decompensation. Before occlusion acquisition, the ascending and descending rotational chains should always be neutralised by a physiotherapist.*



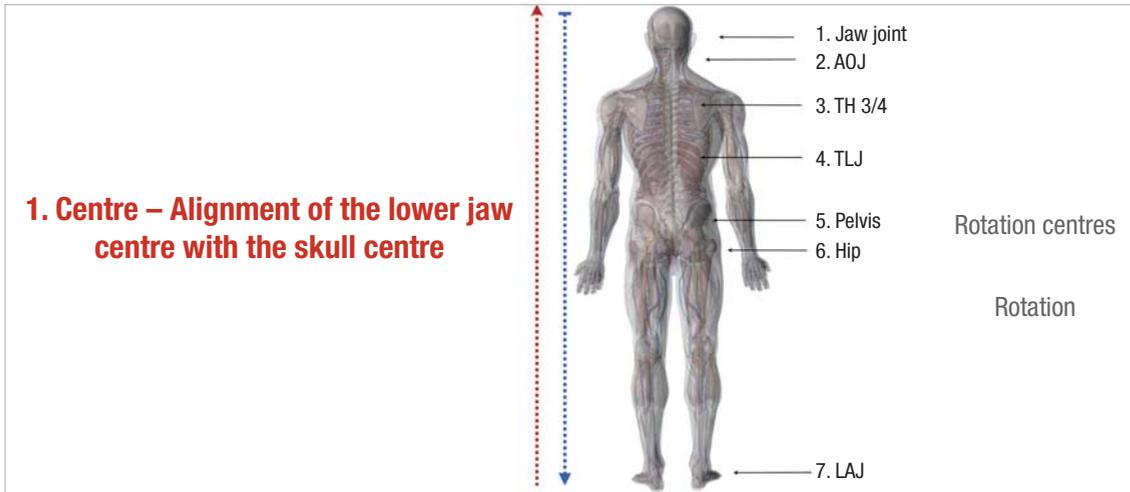
Watch the videos



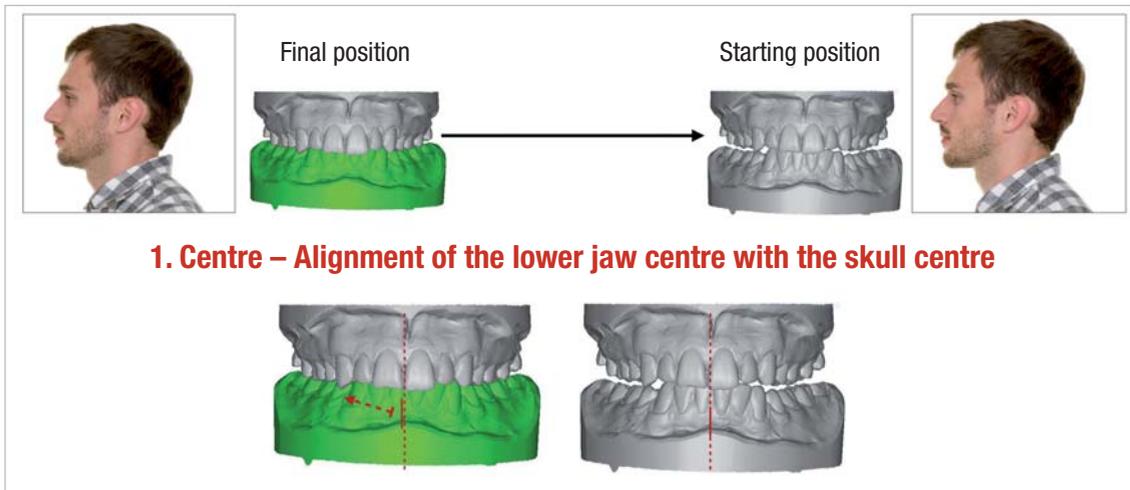
*In general, there are patients who do not tolerate an increase of the bite-raising, but also those who do. This attitude must be determined in advance and in case of height tolerance, a position (front/back) must be identified. In this case, the patient had head retention. This means he needed support in the posterior region.*



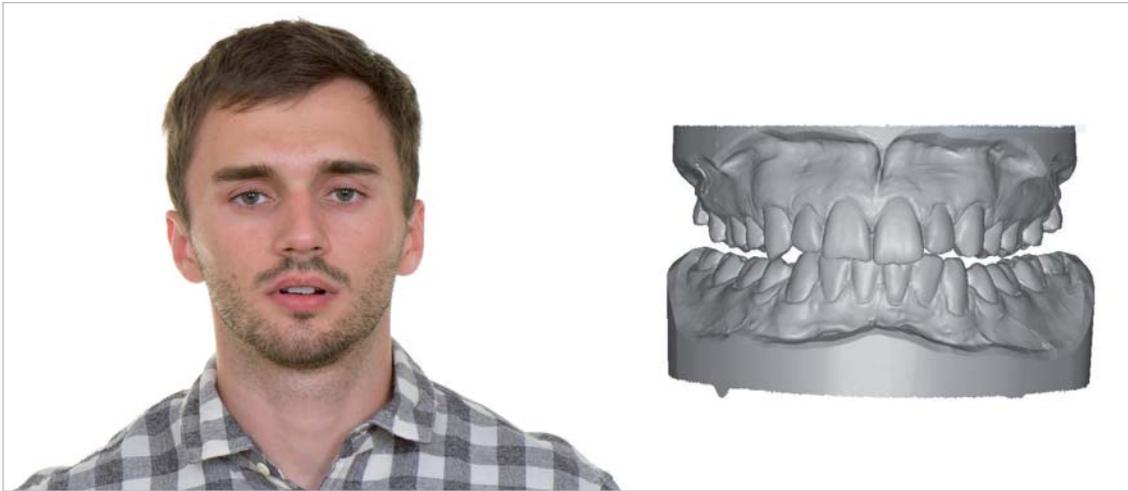
*Seven height and rotation compensation possibilities according to physiotherapist Ralf Hergenroether from a frontal/rear as well as lateral view. The lateral view refers to the height and the frontal/rear view to the rotation.*



*In case the lower jaw is not in the centre of the skull and moves to the right or to the left in the final occlusion position in order to touch the upper jaw, the body must compensate in the rotation centres. Compensation does not take place only at certain points, but in all seven rotation centres with different intensity.*

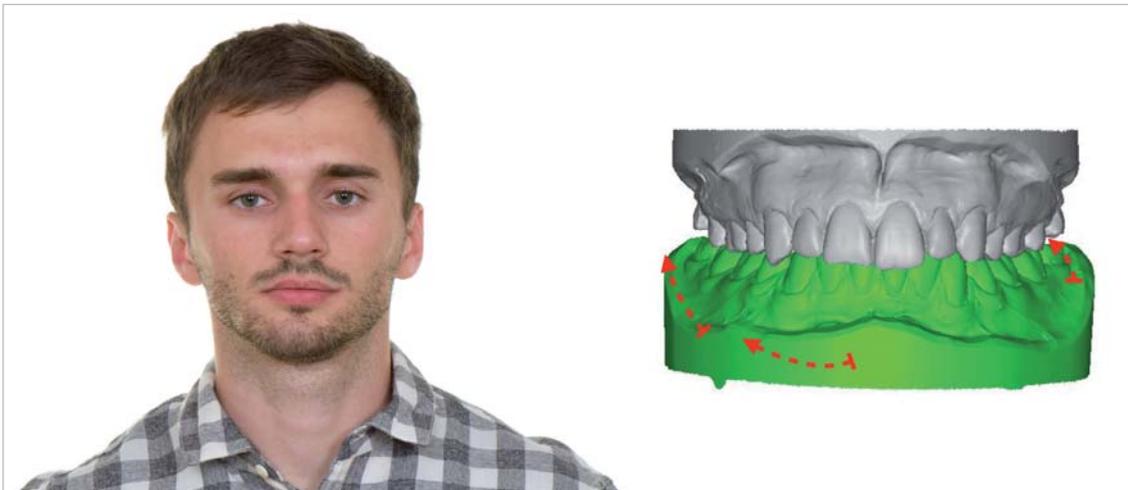


*In this case, the patient's jaw moved in the final position backwards to the right.*

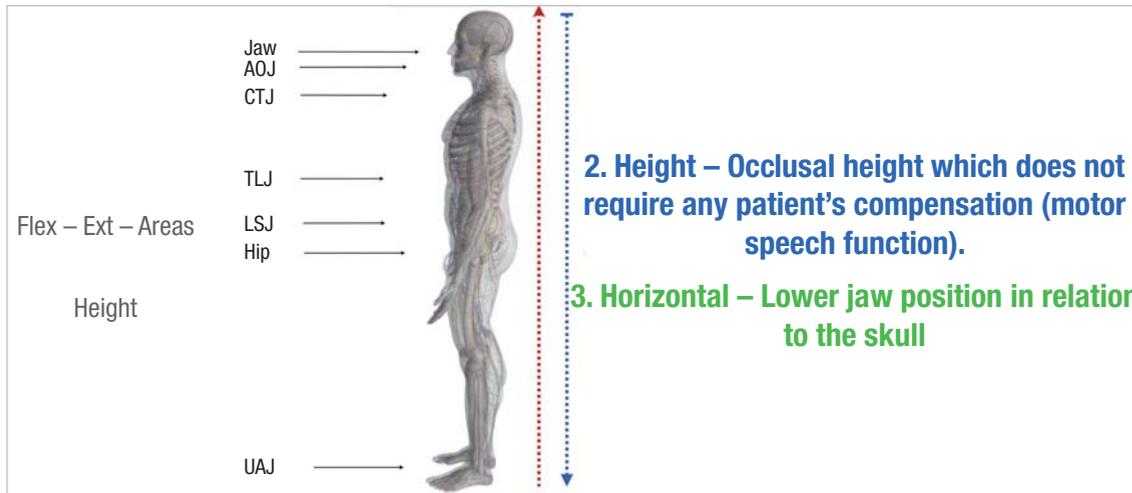


Watch the video

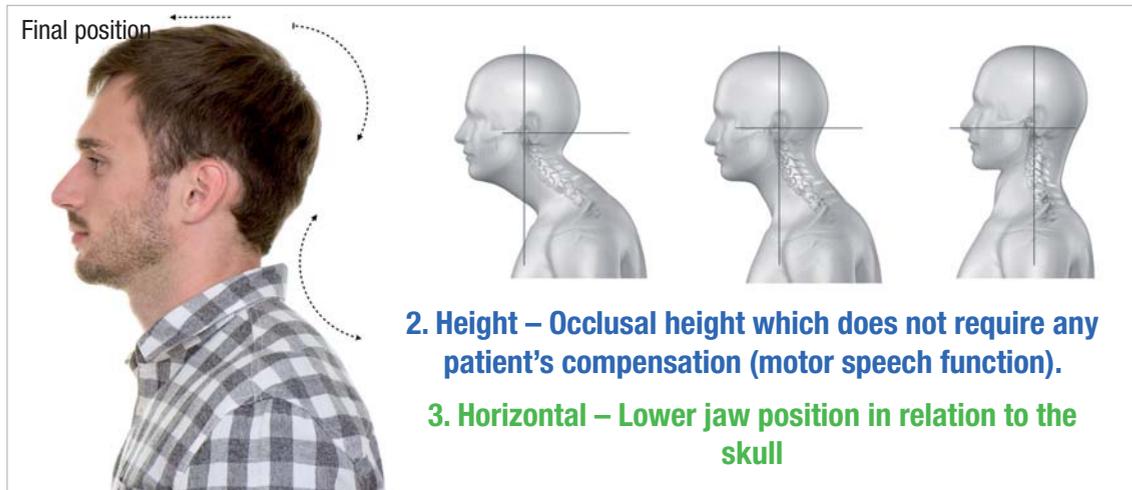
*The model illustrates the starting position in which the lower jaw is aligned to the skull centre with optimal height (not in resting floating position). The height shows the near-contact situation in the front and the increased distance in the molar region.*



*The lower jaw steps out of the skull centre. The final position shows that all teeth touch each other.*



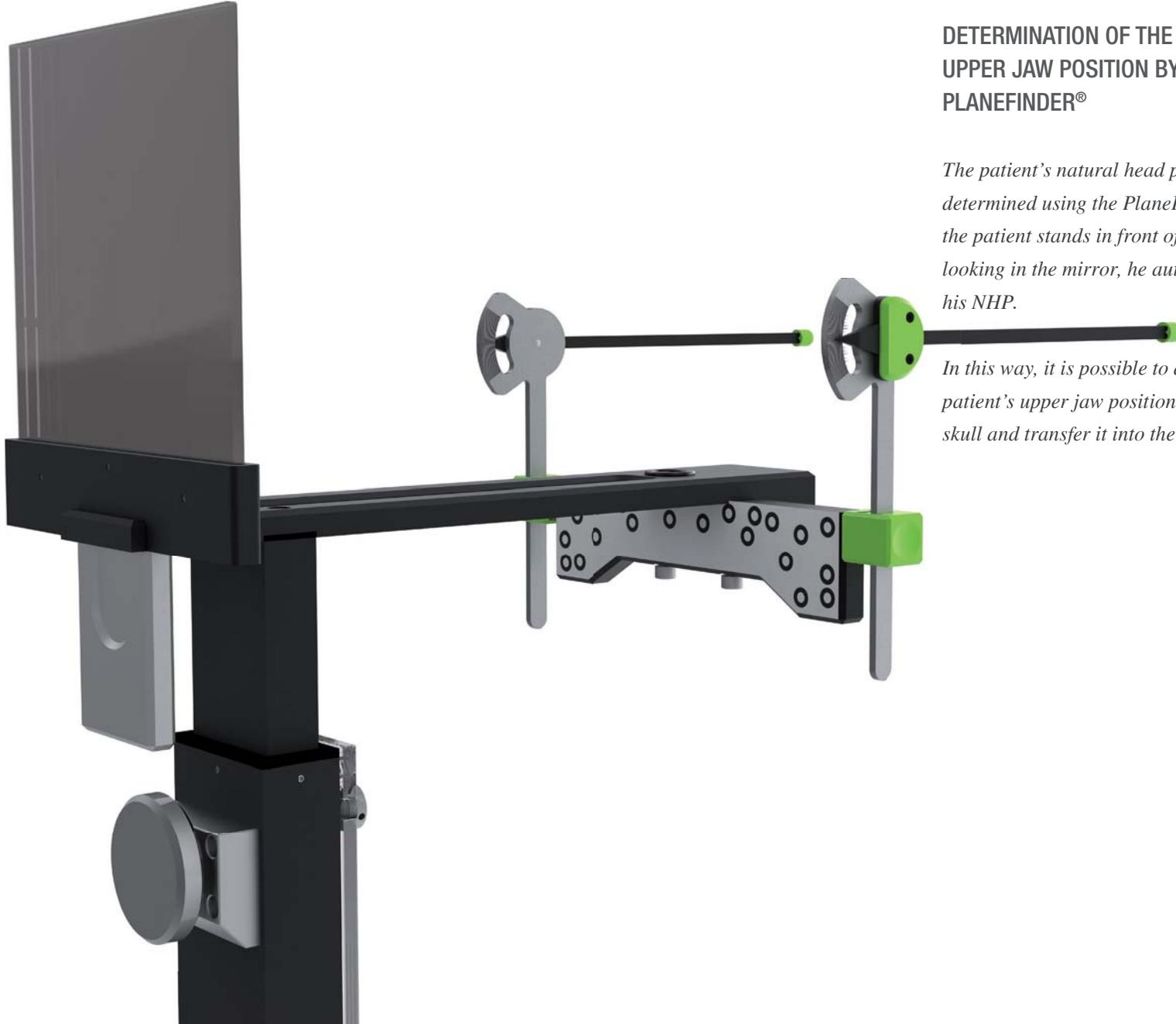
*Lateral view (display of height compensation): compensation takes place from head to toe.*



Watch the video



*Clear patient's head retention in the final position. To allow the teeth touch, compensation occurred not only through the change of the lower jaw position, but also through the skull (see rotation). By tilting the head forward and towards the neck, the patient tried to compensate his system.*

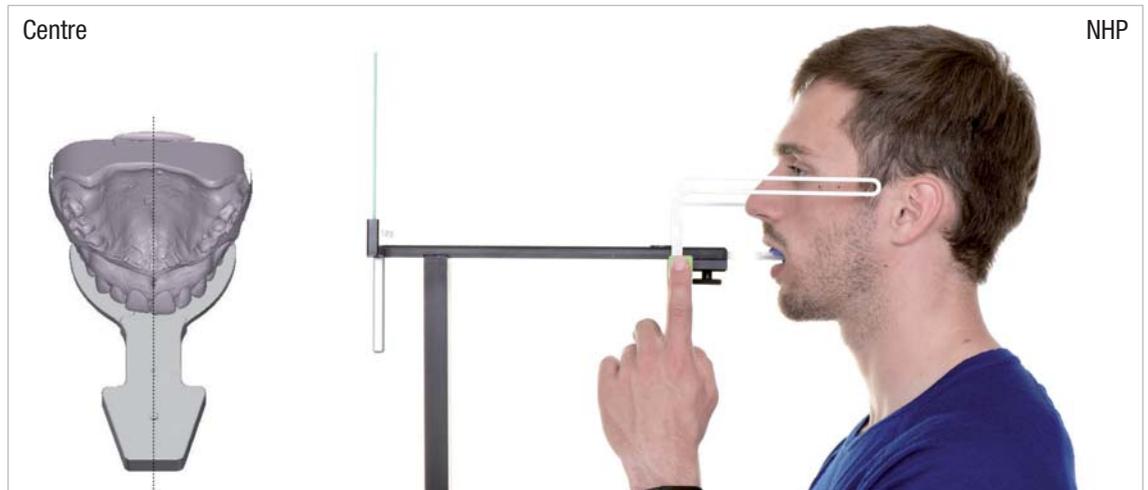


## DETERMINATION OF THE PATIENT'S UPPER JAW POSITION BY MEANS OF THE PLANEFINDER®

*The patient's natural head position (NHP) was determined using the PlaneFinder®. As soon as the patient stands in front of the PlaneFinder® looking in the mirror, he automatically assumes his NHP.*

*In this way, it is possible to determine the patient's upper jaw position in relation to the skull and transfer it into the virtual articulator.*

*During the analysis of the natural head position (NHP), the patient realised the importance of the absence of teeth contact in the posterior region. If the patient stands in front of the PlaneFinder® and the posterior teeth do not touch, a reproducible skull position is achieved. The greater the difference between the starting position (occluded) and the final position (not occluded), the more clearly is visible in the patient's head position. When reproducing the NHP, it is important that the lower jaw does not touch the upper jaw (non-occluded position), as in that case the NHP changes.*



*After analysing the reproducible NHP, the position was acquired.*

## REFERENCED TRANSFER OF THE INFORMATION INTO A 3D ARTICULATOR

*All information determined physically on the patient was transferred into the digital world in order to start the splint design. In this case, models were articulated in the virtual articulator and the starting and final positions were compared.*



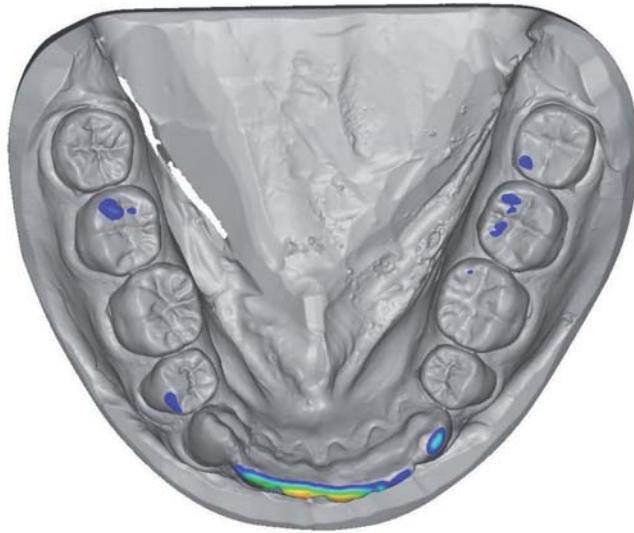
Analysis



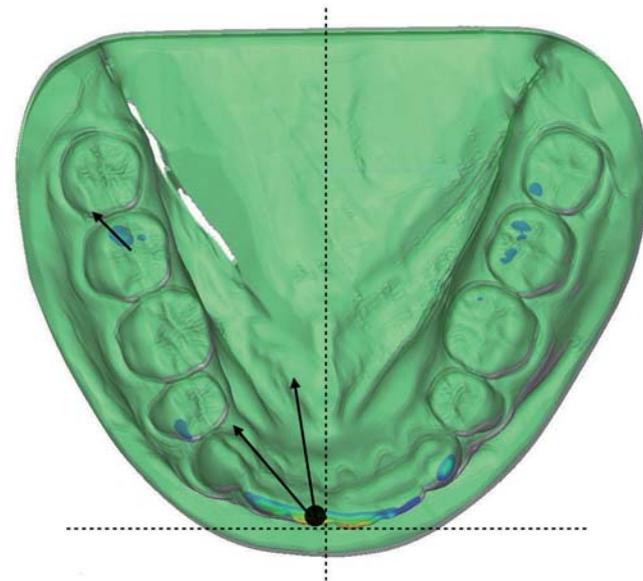
## SPLINT PRODUCTION

*Based on all recorded patient data, a splint was designed in the starting position using the Zirkonzahn.Modifier software by means of the Mock-up software module. In the software, models were articulated in the virtual articulator and the starting and final positions were compared by superimposition. The difference between the two positions was clearly visible.*

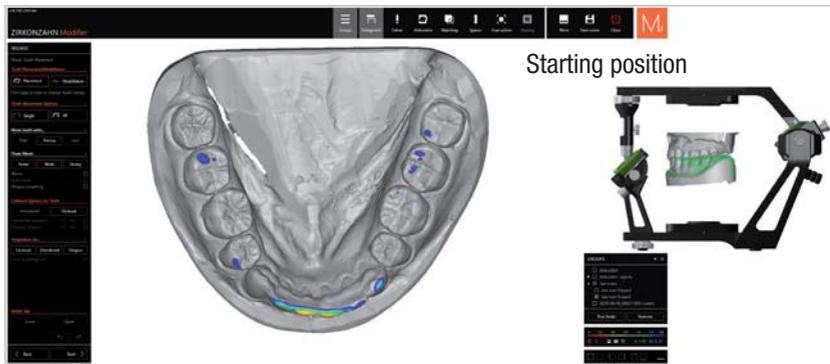
Analysis



1 Starting position



1.2 Final position Compensation



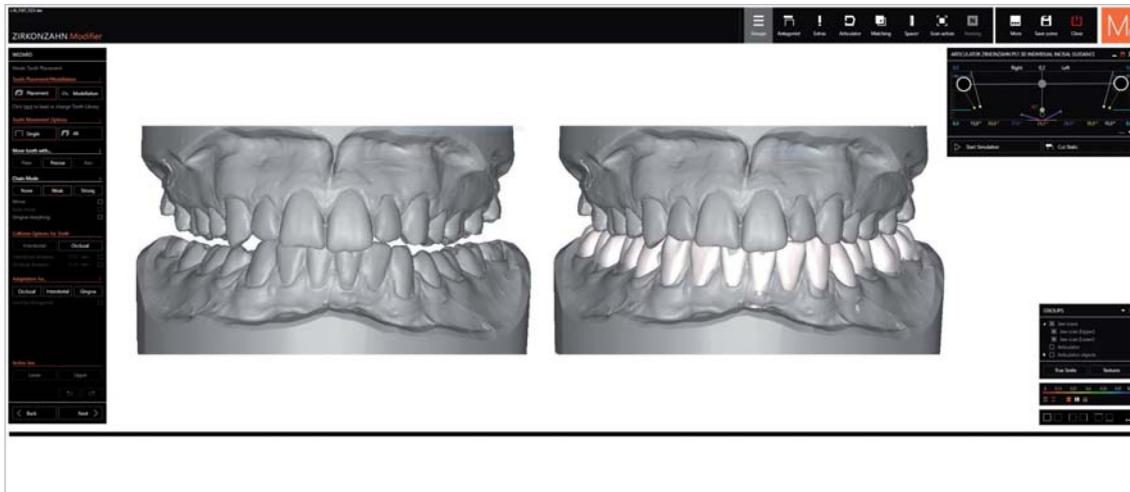
The coloured markings show the abrasions; the lower jaw shifts into its final position.



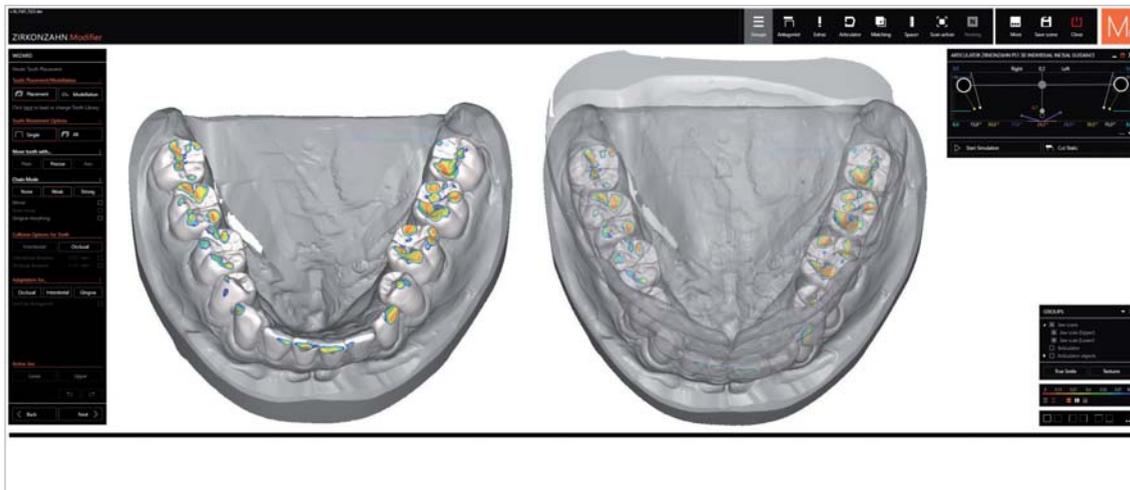
Superimposition of starting and final position. The lower jaw moved downwards to the right.



The Zirkonzahn.Modifier software displays the occlusal contacts, dynamic jaw movements as well as the mandibular movements. When setting the virtual articulator, it is also possible to include the data acquired by means of the PlaneAnalyser II. If, as in this case, no data is available, the virtual PSI articulator allows to perform all lower jaw movements and to adopt patient's setting on the basis of tooth position. The selection of the tooth shape from the Heroes Collection virtual tooth library should be similar to patient's situation to avoid the splint is perceived as a foreign body after insertion.



*The design of tooth position as well as tooth shape was based on patient's natural teeth and the contact situation was improved.*



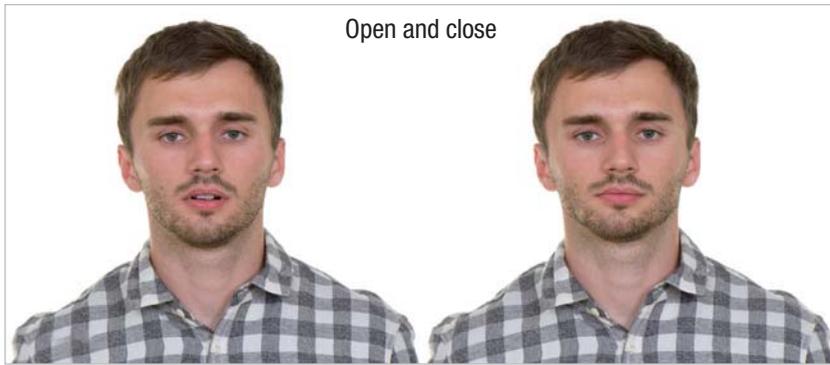
*Analysis of the splint contacts before implementation. The contact area of lateral and anterior teeth was specially designed to give the lower jaw maximum stability in the skull, but at the same time the necessary freedom of movement.*



*At best, a splint should become a comfortable instrument for the patient, designed for supporting and stabilising his starting position. In order to make it comfortable, it was designed based on the natural teeth shape and guide surfaces as well as stable contacts with enough space were created.*



*The final splint was milled out of Therapon Transpa, a particularly transparent and health-friendly resin.*



Watch the video



Right laterotrusion



Protrusion



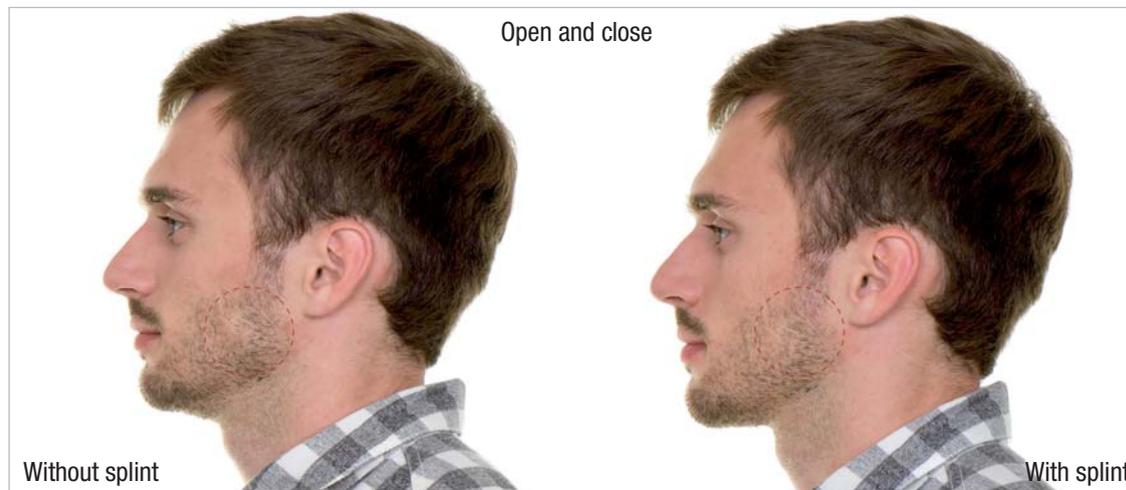
Left laterotrusion

## SPLINT IN PATIENT'S MOUTH

*Immediately after inserting the splint in the mouth, the patient was satisfied of the comfortable feeling. Different phonetic and motor speech tests (iiii, sssss, eeeee) were carried out. Opening, closing, protrusion as well as laterotrusion movements were also checked and no anomalies were found.*

*Since the centre, height and horizontal position of the lower jaw in relation to the skull had been determined in advance during the impression taking, no adjustments had to be made when inserting the splint. After the dentist inserted the splint, the patient visited the physiotherapist. There, several stress tests were performed to determine how the body reacted to the splint. Physiotherapeutically, the system became much*

*more stable: the patient's system only has to apply the necessary physical load for training and by wearing the splint, the descending components were eliminated.*



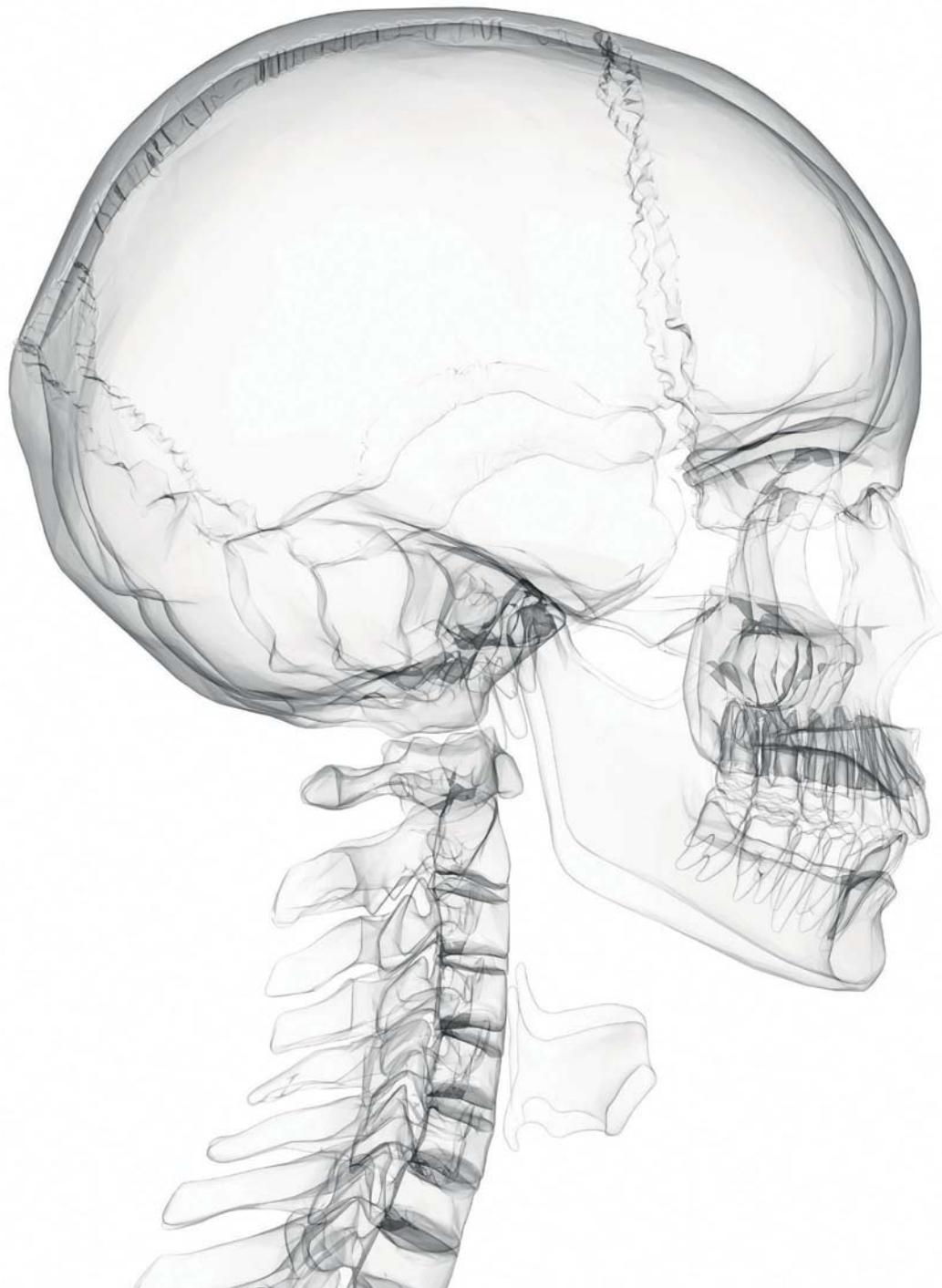
Watch the video

*The muscular relaxation achieved with the splint is clearly visible. The uniform contact ensured in the posterior region by wearing the splint allows the patient to apply forces much more easily. An improvement in head retention was also observed.*



## CONCLUSION

*A few days after the splint was placed, the patient reported an overall improvement of the situation: during strength training his body was much "straighter", during running training he performed movements much more smoothly and his shoulders were more relaxed. In general, his muscles were less tense and strength development, which is essential for sprinting, had improved significantly. In running tests with and without splint (ten times each), significantly shorter times were obtained with the splint. In addition, the patient could successfully compete without suffering from any pain once again, even becoming the Bavarian champion in the 100 and 200-metre sprint in 2020.*



## BIBLIOGRAPHY

- Marquardt S., Plaster U., Kraus K., Hergenroether R.: *“Sportzahnmedizin und Funktion – Ein wesentlicher Zusammenhang im Leistungssport”*, 2021; 72(9); 994-1006
- Plaster U., Marquardt S., Hergenroether R.: *“Schienentherapie und das System Mensch.” Quintessenz Zahntechnik*, 2020; 46(9); 948-966.

*First publication of the patient case in:  
ZWL Zahntechnik Wirtschafts Labor 6/2020; 25-29.*

**Zirkonzahn®**



## HIGH EFFICIENCY THROUGH SPLINT THERAPY

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*All information is subject to change. Errors and omissions excepted. Version: 18/04/2023*