# Clinical Experience with the TruPose™ Head Adjuster for Bore- and C-Arm Linac Workflows

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## Abstract

The TruPose™ Head Adjuster is a mechanical head-positioning device designed to provide pitch, roll, and yaw correction within thermoplastic-mask immobilization workflows. When paired with surface-guided radiation therapy (SGRT), the device allows therapists to address residual rotational head-positioning error before image guidance, rather than relying solely on manual mask manipulation or downstream couch correction.

This white paper summarizes a clinical evaluation performed at AdventHealth Celebration using a Varian TrueBeam linear accelerator integrated with AlignRT. TruPose was used during CT simulation and treatment setup for approximately 25-30 selected patients, predominantly in head-and-neck workflows, with limited intracranial stereotactic radiosurgery/stereotactic radiotherapy (SRS/SRT) use. Five experienced radiation therapists, each with at least five years of post-graduate clinical experience, used the device during the evaluation period.

In this limited clinical evaluation, the device integrated well with the existing SGRT setup workflow. Therapists reported that it was intuitive, reduced the physical effort associated with residual rotational correction, and improved confidence in achieving the simulated head pose before cone-beam CT (CBCT) acquisition. Informal timing observations suggested faster convergence to acceptable rotational alignment compared with manual repositioning.

Retrospective review of the AlignRT real-time deltas and pre-treatment CBCT couch corrections showed a substantial reduction in patient positional shifts after SGRT setup with TruPose-assisted rotational correction. Mean absolute SGRT pitch decreased from 2.2° to 0.54°, roll from 1.8° to 0.75°, and yaw from 0.95°

to 0.82° before CBCT acquisition. Residual CBCT-based corrections were still required, with mean absolute CBCT corrections of 2.1 mm vertical, 1.3 mm longitudinal, 1.2 mm lateral, 0.32° pitch, 0.27° roll, and 0.34° yaw.

The device may be especially valuable in bore-linac environments where six-degree-of-freedom (6DoF) couch correction is unavailable. In 6DoF-equipped C-arm environments, it should be viewed as complementary rather than redundant: TruPose corrects head position before imaging, while the couch corrects whole-patient alignment after image registration. Prospective comparative analysis is warranted to quantify setup time, residual rotational error, couch-correction magnitude, and inter-therapist variability.

## 1 Background and Clinical Rationale

Accurate and reproducible head position is central to cranial, head-and-neck, and stereotactic radiotherapy workflows. Conventional immobilization relies on indexed devices, headrests, thermoplastic masks, lasers, and image guidance. These tools are effective, but residual rotational setup error can remain after initial positioning, particularly when individual variations at the head, neck, shoulders, and mask interfaces do not reproduce the simulation pose exactly.

SGRT provides a non-ionizing method for real-time surface-based patient positioning and motion monitoring. Contemporary guidance from AAPM TG-302 and ESTRO-ACROP describes SGRT roles in patient setup, monitoring, commissioning, and quality assurance across simulation and treatment environments [1,2]. SGRT does not replace image guidance where internal anatomy must be verified, but it can improve the pre-imaging starting position and provide continuous feedback during setup [1-3].

In head-and-neck workflows, surface guidance is clinically attractive because the face and upper neck can provide useful external reference geometry. However, head-and-neck positioning is not purely rigid: neck flexion, shoulder posture, mask seating, weight loss, and anatomy deformation can produce differences between surface alignment and internal anatomy. Published work supports the ability of surface imaging to detect rigid setup errors while also emphasizing the need for careful region-of-interest selection and continued image-guided verification when clinically appropriate [4,5].

The clinical question addressed by this white paper is not whether SGRT or CBCT should be used. Rather, it is whether a mechanical head-positioning interface can make residual rotational correction more controlled, reproducible, and efficient before CBCT acquisition.

## 2 Device and Workflow Overview

The TruPose Head Adjuster consists of an indexable base and head-plate assembly designed for use with selected thermoplastic mask systems. In the evaluated configuration, the device indexed to the treatment couch using standard indexing and was incorporated into the department's existing TrueBeam/AlignRT workflow.

Three external adjustment knobs allow the therapists to perform pitch, roll, and yaw corrections. The intended clinical value is to adjust head position manually while therapists observe live SGRT rotational deltas. This creates a direct feedback loop: residual rotation is identified by SGRT, corrected through the device, and then verified with CBCT according to the institutional image-guidance workflow.

Compatibility and load specifications referenced in this draft reflect current vendor documentation provided for the evaluated device configuration. Sites should verify mask-system compatibility, accessory configuration, couch indexing, load limits, and imaging/planning implications against the current instructions for use before clinical implementation.

## 3 Clinical Evaluation Setting and Approach

A clinical experience evaluation was conducted at AdventHealth Celebration using a Varian TrueBeam platform integrated with AlignRT. TruPose was used during CT simulation and treatment setup for approximately 25-30 selected patients. The evaluated cohort was predominantly composed of head-and-neck cases, with a limited intracranial SRS/SRT subset.

Five experienced radiation therapists participated in the evaluation. Each therapist had at least five years of post-graduate clinical experience. Patients were positioned according to standard departmental practice using immobilization indexing and SGRT. When residual pitch, roll, or yaw was observed on the AlignRT display, therapists used the TruPose adjustment knobs under live SGRT feedback before acquiring pre-treatment CBCT.

Observations were collected qualitatively through therapist feedback, case-level notes, and informal timing estimates. The evaluation was supplemented by retrospective descriptive review of available AlignRT real-time deltas and CBCT couch corrections. This evaluation was not designed as a formal prospective clinical trial, dosimetric study, or time-and-motion study. Findings should therefore be interpreted as early clinical-use observations with descriptive setup metrics rather than statistical evidence of comparative performance.

### 3.1 Retrospective Descriptive Setup Metrics

AlignRT real-time deltas and pre-treatment CBCT couch corrections were reviewed across approximately 250 treatment fractions. Because multiple fractions were obtained from the same patients, the data was interpreted descriptively and not treated as statistically independent observations for inferential testing.

AlignRT values were reviewed at two workflow timepoints: after initial setup and after completion of the SGRT setup immediately before CBCT acquisition. Translational setup corrections were performed using the department's standard SGRT workflow, including ROI-based setup and Postural Video guidance. TruPose was used specifically for residual pitch, roll, and yaw correction under live AlignRT feedback.

Departmental SGRT setup thresholds were 2 mm / 2° for head-and-neck treatments and 1 mm / 1° for SRS/SRT treatments. Because the dataset was predominantly head-and-neck, aggregate SGRT results were interpreted primarily against the head-and-neck threshold. The limited SRS/SRT subset was reviewed separately; no SRS/SRT threshold violations were observed.

SGRT and CBCT values were interpreted as complementary setup indicators rather than interchangeable measures of positioning accuracy. SGRT real-time deltas represent surface-based registration relative to the reference surface, whereas CBCT couch corrections represent image-guided registration of internal anatomy.

## 4 Representative SGRT Workflow

| Step | Workflow action | Purpose |
|---|---|---|
| 1 | CT simulation with TruPose in the intended treatment configuration | Capture patient, immobilization, and device geometry in the reference setup |
| 2 | Initial indexed setup at treatment | Reproduce couch, mask, headrest, and device indexing |
| 3 | Live AlignRT assessment | Identify residual translational and rotational deltas relative to the reference surface |
| 4 | Standard SGRT translational/postural setup | Use ROI-based setup and Postural Video guidance to bring translational/postural deltas below departmental thresholds |
| 5 | TruPose pitch, roll, and yaw correction | Mechanically reduce residual rotational head-pose error under live SGRT feedback |
| 6 | CBCT acquisition and registration | Verify internal anatomy and apply final image-guided couch correction |
| 7 | Treatment delivery and monitoring | Proceed according to departmental SGRT/IGRT and motion-monitoring protocol |

*Table 1. Representative workflow for integrating TruPose into an SGRT-guided setup process.*

## 5 Preliminary Observations and Descriptive Setup Metrics

Over the evaluation period, TruPose was used in selected CT simulation and treatment workflows. Overall, therapists reported that the device was intuitive to use, required minimal workflow disruption, and allowed more controlled correction of residual head pitch, roll, and yaw than manual mask or patient repositioning.

The most consistent feedback related to therapist effort and correction predictability. Manual correction of residual head rotation often requires repeated mask manipulation, re-seating, shoulder adjustment, or

patient coaching. In contrast, the device allowed therapists to make small mechanical rotational adjustments to the head while watching the SGRT deltas change in real time.

The descriptive setup metrics below are intended to characterize the evaluated workflow. They should not be interpreted as statistical proof of accuracy improvement because the evaluation was selected-case, short in duration, and not designed with a matched comparator cohort.

### 5.1 SGRT Real-Time Delta Findings

Across approximately 250 fractions, the SGRT setup sequence reduced mean absolute translational deltas from 15.2 mm to 1.56 mm vertically, 12.3 mm to 1.23 mm longitudinally, and 14.3 mm to 0.89 mm laterally. These translational reductions reflect the department's standard SGRT setup workflow rather than TruPose-specific mechanical correction.

TruPose was used specifically for residual rotational correction. Mean absolute SGRT pitch decreased from 2.2° to 0.54°, roll decreased from 1.8° to 0.75°, and yaw decreased from 0.95° to 0.82° before CBCT acquisition. The largest observed reductions were in pitch and roll. Using root-sum-square component magnitudes, the rotational magnitude decreased from approximately 3.00° after initial setup to 1.24° before CBCT acquisition.

Aggregate SGRT values were interpreted primarily against the department's head-and-neck threshold of 2 mm / 2°, because the dataset was predominantly composed of head-and-neck fractions. The limited SRS/SRT subset was reviewed separately, and no SRS/SRT threshold violations were observed.

| SGRT metric | Initial setup | Final pre-CBCT after SGRT/TruPose setup | Change |
|---|---|---|---|
| **Translational metrics - standard SGRT workflow** | | | |
| Vertical, mm | 15.2 | 1.56 | 13.64 |
| Longitudinal, mm | 12.3 | 1.23 | 11.07 |
| Lateral, mm | 14.3 | 0.89 | 13.41 |
| Translational magnitude, mm (RSS) | 24.22 | 2.18 | 22.04 |
| **Rotational metrics - TruPose-assisted correction** | | | |
| Pitch, degrees | 2.2 | 0.54 | 1.66 |
| Roll, degrees | 1.8 | 0.75 | 1.05 |
| Yaw, degrees | 0.95 | 0.82 | 0.13 |
| Rotational magnitude, degrees (RSS) | 3.00 | 1.24 | 1.76 |

*Table 2. Descriptive AlignRT real-time deltas before and after SGRT setup with TruPose-assisted rotational correction. Translational reductions reflect the department's standard SGRT setup workflow using ROI-based positioning and Postural Video guidance. TruPose was used specifically for residual pitch, roll, and yaw correction under live SGRT feedback. RSS = root-sum-square of the component summary values.*

### 5.2 CBCT Pre-Treatment Shift Findings

After the SGRT setup and TruPose-assisted rotational correction, residual CBCT-based couch corrections remained necessary for final internal-anatomy alignment. Mean absolute CBCT translational corrections were 2.1 mm vertically, 1.3 mm longitudinally, and 1.2 mm laterally, corresponding to a root-sum-square translational magnitude of approximately 2.8 mm.

Mean absolute CBCT rotational corrections were 0.32° pitch, 0.27° roll, and 0.34° yaw, corresponding to a root-sum-square rotational magnitude of approximately 0.54°. These values support the role of SGRT-guided setup and TruPose-assisted rotational adjustment as pre-imaging positioning tools while reinforcing the continued need for CBCT-based internal-anatomy verification and final couch correction.

| CBCT correction metric | Mean absolute correction | Maximum absolute correction |
|---|---|---|
| Vertical, mm | 2.1 | 4.1 |
| Longitudinal, mm | 1.3 | 3.8 |
| Lateral, mm | 1.2 | 2.2 |
| Translational magnitude, mm (RSS) | 2.8 | 6.0 |
| Pitch, degrees | 0.32 | 0.66 |
| Roll, degrees | 0.27 | 0.45 |
| Yaw, degrees | 0.34 | 0.56 |
| Rotational magnitude, degrees (RSS) | 0.54 | 1.0 |

*Table 3. Pre-treatment CBCT couch corrections after SGRT setup and TruPose-assisted rotational correction. CBCT corrections represent residual internal-anatomy registration and final image-guided couch correction. Values are reported descriptively across approximately 250 fractions. RSS = root-sum-square of the component summary values.*

### 5.3 Workflow Comparison

| Workflow element | Conventional manual repositioning | TruPose-assisted correction observed in this evaluation |
|---|---|---|
| Time to resolve residual pitch, roll, or yaw on SGRT after initial setup | Often required iterative mask or patient adjustment, with repeated surface checks | Informal observations suggested faster correction using adjustment knobs under live AlignRT feedback |
| Therapist effort and variability | Operator-dependent; influenced by patient anatomy, mask fit, shoulder position, and therapist technique | Lower-effort mechanical adjustment; therapists reported more reproducible correction behavior |
| Pre-CBCT head pose | Residual rotation may persist after manual repositioning, particularly when correction requires mask manipulation | Therapists reported improved confidence that the head pose more closely matched simulation before CBCT |
| Patient comfort during correction | Repeated mask or patient manipulation may be uncomfortable and may disturb immobilization | Corrections were made through the device rather than by direct manipulation of the mask or patient |

*Table 4. Qualitative workflow comparison. Timing impressions were informal and were not collected under a formal time-and-motion protocol.*

### 5.4 Observed Workflow Advantages

1. **Faster convergence to the simulated head pose.** The adjustment knobs produced predictable changes in SGRT rotational deltas, reducing the trial-and-error associated with manual mask manipulation.
2. **Fewer pre-CBCT rechecks.** Residual pitch, roll, and yaw were typically addressed in a single adjustment cycle during the evaluation, although this was not formally quantified.
3. **Lower therapist effort.** Corrections were made mechanically at the device rather than by physically manipulating the patient or mask.
4. **Improved confidence in pre-imaging setup.** Therapists reported greater confidence that the patient entered CBCT closer to the simulated head pose.

### 5.5 Head-and-Neck Workflow Experience

Because the initial case mix was predominantly head-and-neck, the strongest direct evidence from this evaluation relates to head-and-neck workflow integration. The device was most useful when residual head rotation remained after the patient had been indexed, masked, and brought close to the surface reference. In that setting, the mechanical adjustment provided a more controlled correction pathway than repeated mask manipulation.

For extended head-and-neck treatments, the distinction between head pose and whole-patient pose is clinically relevant. Residual head rotation may arise from neck flexion, mask seating, shoulder position, or differences in patient relaxation. Correcting the entire couch can align the target region after image

guidance, but it may also change the relationship of the shoulders, lower neck, and thorax to the planned setup. Patient-interface head correction offers an additional option before image acquisition.

### 5.6 Potential Relevance for SRS/SRT Workflows

The SRS/SRT sample in this initial evaluation was limited. Stereotactic conclusions should therefore be considered preliminary and hypothesis-generating rather than definitive.

The rationale for including SRS/SRT remains clinically important. Single-isocenter treatment of multiple brain metastases is sensitive to rotational error because off-axis targets experience larger spatial displacement for a given angular deviation. Published analyses have shown that target coverage risk increases with decreasing target volume, increasing rotational error, and increasing target distance from isocenter [8]. For that reason, controlled pre-imaging rotational head correction may be clinically valuable, but this specific endpoint should be evaluated in a dedicated stereotactic cohort.

## 6 Value on 6DoF-Equipped Platforms

For centers with 6DoF couch capability, the relevant clinical question is whether patient-interface head correction provides value beyond whole-couch correction. In this evaluation, TruPose and the 6DoF couch were best understood as complementary tools rather than redundant technologies.

A 6DoF couch rotates the entire patient. A head adjuster rotates only the head. This distinction matters because residual rotational error at the head is frequently driven by neck flexion, shoulder posture, or mask seating. These factors may not represent a true whole-body setup error.

In selected cases, TruPose appeared to improve the pre-imaging starting pose and reduce therapist effort before CBCT. The 6DoF couch remained available for final image-guided whole-patient correction after registration. The descriptive CBCT data reported here show that residual image-guided corrections remained necessary, reinforcing the complementary role of patient-interface correction and final CBCT-based couch correction.

| Correction mechanism | Primary correction target | Best use in workflow |
|---|---|---|
| TruPose Head Adjuster | Head position | Before CBCT, under live SGRT feedback |
| 6DoF couch | Whole-patient position and orientation | After image registration, as final image-guided correction |
| Used together | Improved pre-imaging head pose plus final IGRT correction | Potentially fewer correction iterations; requires larger prospective validation |

*Table 5. Complementary roles of patient-interface correction and 6DoF couch correction.*

## 7 Integration with SGRT

TruPose integrated naturally with the evaluated AlignRT workflow. The live rotational deltas displayed by AlignRT mapped conceptually to the device's pitch, roll, and yaw adjustments, allowing therapists to reduce residual rotation in real time before CBCT.

No line-of-sight or surface-tracking interference attributable to the device was observed during the evaluation. This statement reflects local experience with the evaluated TrueBeam/AlignRT geometry and should be verified by each site as part of implementation, particularly if camera geometry, bore geometry, immobilization accessories, or treatment-room constraints differ.

The device should be incorporated into CT simulation if it will be used at treatment, particularly when there is any possibility of beam-path intersection or when the device changes patient support geometry.

## 8 Clinical Use Cases

| Use case | Observed or potential value | Evidence status in this evaluation |
|---|---|---|
| Head-and-neck radiotherapy | May reduce manual mask manipulation and improve confidence in pre-CBCT head pose | Most represented use case; aggregate SGRT/CBCT data primarily reflect this workflow |
| Bore-linac workflows | Potentially valuable where 6DoF couch correction is unavailable | Not directly evaluated on a bore linac; workflow relevance inferred |
| 6DoF-equipped C-arm linacs | May complement couch correction by improving the pre-imaging starting pose | Directly evaluated on TrueBeam/AlignRT with descriptive SGRT and CBCT setup metrics |
| Intracranial SRS/SRT | Potentially relevant because rotational error can have meaningful geometric consequences | Limited early experience; no threshold violations observed in the small subset; dedicated study needed |
| Minimal-immobilization or maskless workflows with SGRT | Potential future application requiring controlled rotational correction and continuous monitoring | Not validated in this evaluation |

*Table 6. Observed and potential clinical use cases.*

# 9 Limitations and Planning Considerations

## 9.1 Evaluation Design

This was a selected-case, short-duration clinical experience evaluation. It was not randomized, blinded, or powered to measure changes in setup time, residual rotational error, couch-correction magnitude, image frequency, patient comfort, or treatment delivery outcomes.

The observations reported here are based on therapist feedback, case-level notes, informal timing impressions, and retrospective descriptive setup metrics. Quantitative claims regarding time savings, accuracy improvement, or inter-therapist variability should not be made until evaluated in a prospective or matched-control design.

## 9.2 Descriptive Data Limitations

The SGRT and CBCT values were summarized descriptively across approximately 250 fractions. Multiple fractions were obtained from the same patients, so the observations should not be treated as independent samples for inferential statistics. The current summary reports mean absolute component values and root-sum-square component magnitudes rather than full per-fraction distributions. Future analyses should calculate per-fraction vector magnitudes, report medians and interquartile ranges, and stratify by treatment site and fraction number.

The aggregate SGRT data are dominated by head-and-neck fractions and should not be interpreted as representative of SRS/SRT performance. The SRS/SRT subset was small and was reviewed separately; no SRS/SRT threshold violations were observed, but broader stereotactic conclusions require a larger dedicated cohort.

SGRT real-time deltas and CBCT couch corrections represent different registration targets: external surface geometry versus internal anatomy. As a result, the datasets should be interpreted as complementary workflow and setup indicators rather than direct substitutes for one another.

## 9.3 Selected-Case Evaluation

TruPose was used in selected patients during this initial evaluation. Some cases were excluded because of beam-path considerations or workflow constraints. As a result, the observations may not generalize to all head-and-neck, cranial, or stereotactic workflows.

Case selection, beam arrangement, immobilization approach, CT simulation setup, and departmental workflow should be reviewed before routine clinical adoption.

### 9.4 Beam-Path Considerations for Vertex and Steep Superior Fields

The adjustment knobs and supporting mechanical structure introduce additional material near the head plate that is not present in a conventional thermoplastic-mask setup. During this evaluation, some cases were not selected for device use because of beam-path or workflow considerations.

For many posterior, lateral, and anterior beam geometries used in routine head-and-neck and intracranial treatments, the device is expected to remain outside the primary beam path. However, vertex fields or steeply angled superior beams may intersect the knobs or supporting hardware. When this occurs, the device geometry should be captured at CT simulation and represented appropriately in the treatment planning system according to institutional practice.

This consideration is not unique to this device. Similar review is required for any immobilization or positioning component that may enter the treatment beam.

## 10 Future Work

This initial experience supports a more structured prospective or matched retrospective study. Because descriptive SGRT and CBCT metrics have now been reviewed, the next phase should move from aggregate component summaries to per-fraction vector analysis, matched comparison, and predefined endpoints.

## 11 Conclusion

In this clinical experience evaluation on a Varian TrueBeam platform with AlignRT, the TruPose Head Adjuster integrated well with existing CT simulation and treatment setup workflows. The device was used primarily in head-and-neck cases, with limited intracranial SRS/SRT experience, and was operated by five experienced radiation therapists.

Therapists reported that the device was intuitive to use and provided a controlled mechanical method for correcting residual pitch, roll, and yaw before CBCT acquisition. Informal observations suggested reduced therapist effort and faster convergence to the simulated head pose compared with manual repositioning.

Retrospective descriptive setup metrics provide preliminary objective support for these workflow observations. Standard SGRT setup reduced surface-guided translational deltas before CBCT, while TruPose-assisted correction reduced residual SGRT rotational deltas, with mean absolute pitch decreasing from 2.2° to 0.54°, roll from 1.8° to 0.75°, and yaw from 0.95° to 0.82°. After SGRT-guided setup and TruPose-assisted rotational correction, residual CBCT corrections remained necessary, with mean absolute corrections of 2.1 mm vertical, 1.3 mm longitudinal, 1.2 mm lateral, 0.32° pitch, 0.27° roll, and 0.34° yaw.

The device may be particularly relevant for bore-linac environments without 6DoF couch correction, although bore-linac workflows were not directly evaluated in this initial TrueBeam/AlignRT experience. On

6DoF-equipped C-arm platforms, the device appears best positioned as a complementary tool that improves the pre-imaging head pose while leaving final image-guided correction to the couch. Larger prospective or matched retrospective analysis is warranted to define its impact on setup time, residual rotational error, couch-correction magnitude, and inter-therapist variability.

## Disclosures

The author has no financial relationship with Standard Imaging, Inc. The TruPose Head Adjuster was provided for clinical evaluation. Standard Imaging did not control the clinical evaluation, data interpretation, or manuscript conclusions. The observations and opinions expressed in this white paper are those of the author and reflect clinical experience at AdventHealth Celebration.

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