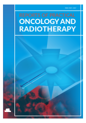

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RESEARCH PAPER

A prospective, comparative evaluation of an augmented reality tool (Postural Video™) *vs.* standard SGRT for efficient patient setup

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ABSTRACT

Background: Surface guided radiation therapy (SGRT) for patient positioning and motion management during radiation therapy is used on ~40% of US linear accelerators. Postural Video™ (PV), an augmented reality tool for SGRT, is showing a live patient video feed against an outline of the intended treatment position, at patient setup and intrafraction monitoring. A study was performed to assess any potential additional values of SGRT with PV, versus SGRT alone.

Materials and methods: Two radiation therapy centers, comparable across patient numbers, case mix, treatment times and staff experience, were selected to compare performance difference in SGRT with/without PV, focused on productivity. Site A used SGRT alone for patient setup, while Site B used SGRT with PV. Both sites were proficient in the use of SGRT prior to the study. 250 treatment delivery fractions per site were analyzed, evaluating average patient setup time, average wait time and frequency of repeated radiographic imaging. A qualitative survey completed information of PV impact on setup quality, access, and efficiency.

Results: Average time saving per patient by introducing PV is 28.8% plus additional 60 sec time saving in patient wait time. Repeated radiographic imaging was reduced by 63% ($p < 0.05$). Qualitative ratings and open comments supported PV being included in standard SGRT.

Conclusions: The scope of this work was to evaluate a feature under economic considerations. This data demonstrates an increase in quality, safety, accuracy and efficiency of patient setup with PV, and allows us to make an objective, business-focused assessment of the investment in PV.

Keywords: surface-guided radiotherapy; reduced imaging; time saving; efficiency; return on invest

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Introduction

Health technology assessment (HTA) [1–3] is usually performed on a governmental level, but it is equally important for an integrated cancer care provider with numerous associated sites active on three continents. To maintain a high level of quality and consistency for clinical quality, safety and effectiveness in a large multi-center network, also the clinical use and related advantages of technology used must be assessed from an economical point of view. This work aims to investigate the use of a feature that is subject to a charge.

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An evaluation of the assets within our network showed that Surface Guided Radiation Therapy (SGRT [4–6]) systems were in varying stages of utilization, education, and system versions. AlignRT (Vision RT, London, UK) [7] is used in our network. An accompanying overhaul resulted in a technology and utilization refresh, conducted over approximately three months, which aligned most of our network to adopt similar SGRT workflows and product versions.

In addition to the core SGRT system with 6DoF registration for patient setup and intrafraction monitoring, our clinics used an augmented reality tool, Postural Video™ (PV), which overlays the reference outline for the patient's treatment position on a live, multi-angle video feed.

PV had anecdotal benefits and positive feedback from users, but due to the large investment required to standardize PV across the network, a data-driven decision analysis on the return on investment (ROI) [8] for the company was required. Consequently, the value of PV with regards to treatment quality, workflow implication, performance and staff satisfaction was investigated to justify the costs of the license. A prospective cohort study was performed to assess any potential additional values of SGRT with PV, versus SGRT alone. Therefore, data was collected to measure the ROI on installing PV in clinics, based on their patient volume and to assess the overall value of PV in the clinical setting.

Materials and methods

Postural Video

PV is a complementary feature to AlignRT (version 6.2 and above). By superimposing virtual outlines, a direct visual verification of the postural position of the patient or adjustable devices such as breast boards or additional positioning devices can be performed [9]. It is used to set up the patient with an outline of the reference surface and a live video stream of the patient. The feature gives a real-time view of the patient's overall alignment relative to their reference position (Fig. 1).

Identify comparable clinics

Based on our centrally located records, we have compared patient ethnics, case mix, patient load, but also staffing ratio and experience of the team. We carefully identified two sites (Sites A and B) in East and West Florida that were very comparable regarding their procedural and patient related conditions in our network. The two sites were selected to utilize either AlignRT alone without PV (Site A), or AlignRT with PV (Site B) during the study data

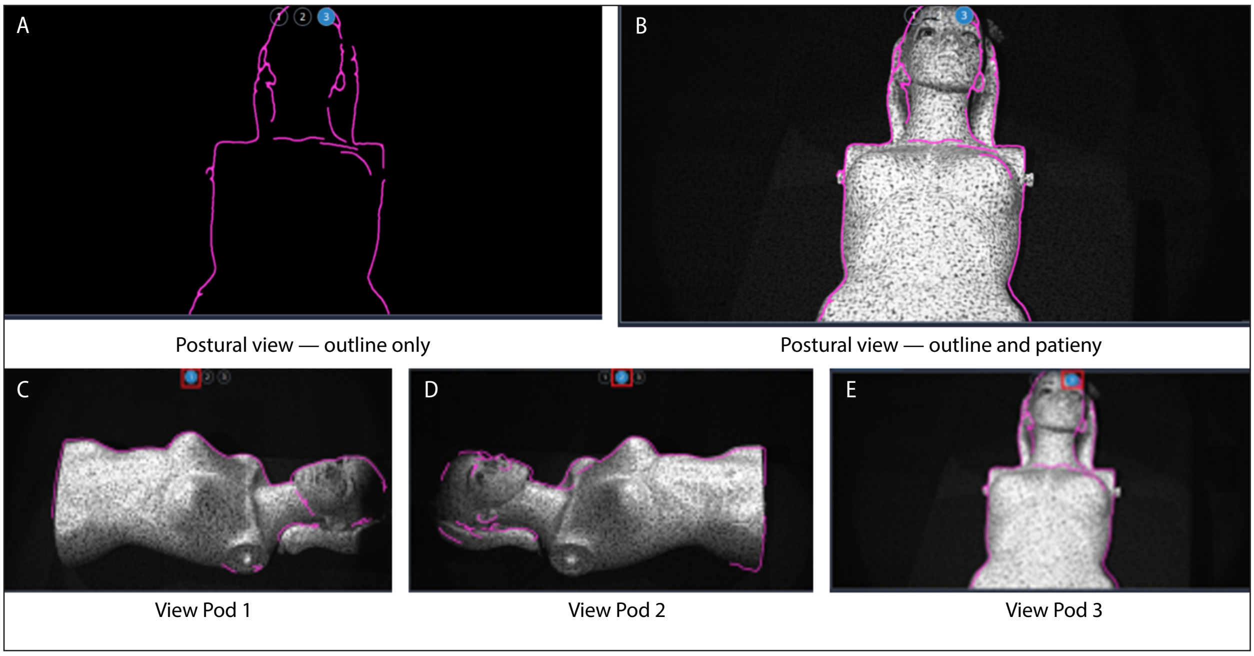

Figure 1. Postural Video feature. **A.** Postural view – outline only; **B.** Postural view — outline and patient; **C.** View Pod 1; **D.** View Pod 2; **E.** View Pod 3

Table 1. Setup timing data for site A (AlignRT without PV), and Site B (AlignRT with PV)

Treatment area	Fraction No. Site A	Fraction No. Site B	Setup time, Site A [sec (1 std)]	Setup time, Site B [sec (1 std)]	Setup time Reduction by PV [sec (%)]
Prostate/Pelvis	135	146	72.6 (33.4)	48.9 (49.7)	23.7 (32.6%)
Lt Breast (all DIBH)	14	12	96.0 (7.9)	62.1 (17.2)	33.9 (35.3%)
Rt Breast	20	20	92.4 (12.9)	56.3 (28.0)	36.1 (39.1%)
Lung	38	39	72.5 (17.7)	56.2 (27.9)	16.3 (22.5%)
Abdomen*	20	17	178.1 (19.8)	161.8 (157.4)	16.3 (9.1%)
Other entities	22	16	106.1 (76.5)	77.2 (40.2)	28.9 (27.2%)
All data	249	250	85.5 (40.0)	60.9 (64.3)	24.6 (28.8%)

DIBH — deep inspiration breath hold radiotherapy; *including liver, pancreas, and other abdominal tumor sites

collection period. Both sites have an experienced team treating on a Varian Edge machine, a similar case mix, and a case load of approx. 30 patients per day. Each site collected data for 250 treatment delivery incidences.

To consider only workflow related items, no patient information was collected. To ensure anonymity of staff and patients, no schedule timestamps were recorded. The only information collected was treatment location and setup time duration.

Patients were categorized into six groups based on their treatment area (Tab. 1). Evaluable setup data were available for 249 and 250 treatments for Site A and B, respectively.

The average patient setup time, a re-image rate following initial IGRT (indicating the accuracy of initial setup with SGRT ± PV), and average wait time (delay in being called for treatment after the scheduled appointment time) comparison were chosen as endpoints to compare the sites.

Besides this quantitative data to analyze the value of PV from a clinical and economical perspective, also soft factors like treatment quality, staff and patient satisfaction were recorded.

The local treatment teams and the patients were asked to complete a survey to explore the impact of Quality, Access and Efficiency. This qualitative information was validated and summarized as an aid to decision-making, in addition to capturing quantitative information on the impact of adding PV to the AlignRT workflow.

Quantitative data

To assess cumulative imaging dose, the associated cancer risk and the related costs [10], the incidence of required repeat radiographic image was recorded. In addition, both sites collected data on the average time for patient setup and wait times for each treatment fraction. Most patients were treated using intensity-modulated radiation therapy (IMRT) or volumetric modulated arc therapy (VMAT) treatment plans, with a low use of 3D treatments at both sites.

Site A had used PV for a period of one year prior to this study. Average patient wait times were compared between a 3-month period when the site had the PV feature to a 3-month period during the study without PV.

Qualitative endpoints

Qualitative information was captured via a survey distributed to all RTT, Physics and Office Leadership roles at sites with AlignRT systems within the network. Addressing potential additional benefits of using PV over the core AlignRT product, this survey gathered information based on three key criteria:

PV impacting:

- treatment quality advantages;
- the availability of treatment systems to the patient;
- treatment efficiency for the patient.

Within the survey, there were response options using both 5-point Likert-scale answers and free text. There was also distinct language around the impact being due to ‘PV’ (not just AlignRT) to ensure only data assessing the impact of PV was recorded.

Results

Quantitative endpoints

Re-image rate comparison

In the absence of PV, 8 of the 250 treatment fractions (3.2%) at Site A required re-imaging based

Table 2. Survey response Summary

PV provides a positive impact on the following	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No response
Quality	–	–	1	1	24	–
Access	–	–	10	–	15	1
Efficiency	–	1	–	–	24	1

on established internal clinical protocols following the initial radiographic image across breath hold and free breathing treatments. At Site B, with PV, the reimaging instance was 3 out of 250 fractions (1.2%) for breath hold treatments only, or a reduction in the reimaging rate of 63% (5 fewer fractions) with PV versus AlignRT setup alone.

Average setup time comparison

The average set up time was 85.5 s (± 40.0) at Site A (without PV) and 60.9 s (± 64.3) at Site B (with PV). This is a reduction in average overall setup time of 24.6 s per fraction when using AlignRT with PV, versus AlignRT alone (a 28.8% reduction in setup time).

Average wait time comparison

During this study, at Site A when PV was unavailable, the average wait time was 3 minutes per patient. Compared to the three-month period prior to this study when PV was being used, the average wait time was 2 minutes per patient, or 1-minute less wait time on average when using PV.

Qualitative endpoints

End user survey

A total of 42 surveys were completed (of 43 distributed), of which 26 respondents (62%) indicated experience of using both AlignRT alone, and AlignRT with PV. Table 2 summarizes the scaled answers. The open free-text answers (see supplement) further highlight the potential impact of PV.

Discussion and Conclusions

As a private integrated cancer care provider, we have to balance extra costs to the additional benefit of new, more advanced or supplementary technology. Before we buy any new technology, we must ensure that it will actually improve clinical results. And this is not trivial, as to the best of our knowledge, no other investigation was evaluating the fee-based software feature with regards on efficiency and effectiveness before. Therefore, this work evaluates the feature within an inhouse method in our network to provide proof of principle.

Based on Ploqin et al., high personnel costs contribute to 50–60% to the total radiotherapy costs in high-income countries [11]. Therefore, efficiency is key, and features that increase efficiency are highly welcome. Our data shows that PV further reduced patient setup times by 28.8% *vs.* standard SGRT, increasing the linac capacity by one patient per 36 patients treated per day (based on current 15 min treatment times per fraction). This reduction in setup time results from an increase in workflow efficiency. PV provides additional information to facilitate patient setup by allowing direct interactive verification of adjustments. The visualization is simple and easy to understand. It is very intuitive and easy to interpret how to improve the patient setup, leading to higher accuracy.

Treating one additional extra patient per 36 patients per day doesn't sound much, but this means that you reduce (in this example) your treatment related personnel costs by 2.8% per day.

In conducting the economic analysis, a number of assumptions were made. The focus was on the additional space that could be made available for the treatment of additional patients, without making any changes to the wider setting. In the United States, there are 251 working days in 2024 during which treatments are conducted. The mean number of fractions treated per course of treatment is 20, averaging all treatment modalities. One additional patient slot per day will result in 12.55 additional patient treatments per year. Given an average daily case load of 30 patients, this equates to an annual gain of 10.46 patients (calculated as 83% of 12.55).

The cost of PV is approximately 2.8 times the average cost of a course of treatment across all treatment modalities provided by our healthcare and reimbursement system. Consequently, the investment is expected to have reached a positive return after approximately a third of a year.

From the perspective of patient experience, an additional 60 sec reduction in wait time with PV results in a total 84.6 sec time saving between the reduced wait for treatment, and time on the treatment couch. This data is consistent with existing literature [12]. With PV, the setup process is more efficient for the staff and the patient spends less time on the treatment couch. Consequently, treatment slots are kept better, which results in less waiting time for the next patient as they stick better to the schedule. The objective of the staff is to provide the optimal experience for the patient. However, exceeding the scheduled time results in increased pressure and stress for the team. We aim to provide high quality healthcare. Patient satisfaction is an important part of this, as it is the foundation for a good reputation, which is key to being seen as a provider of care experience that delivers the best possible outcome. Little to no waiting time increases patient satisfaction as they can plan their daily routine with confidence.

There were no extremity patients treated at Site B during this study. However, previous data from Site A demonstrated a setup time for an upper extremity with PV was 120 sec, compared to 180 sec without PV (60 sec reduction with PV).

Besides the economic perspective, also treatment quality and patient safety were in scope of this work. Since the invention of IMRT, imaging methods have been continuously developing and are extensively used [9, 13]. Sometimes, there is a lack of awareness for the dose resulting from that imaging, especially in areas where no further dose is desirable. AAPM Task Group 75 is requesting a management for imaging dose during radiotherapy [15]. Unfortunately, a broad implementation of imaging protocol optimization is still to be done. Our in-house investigation shows a significant reduction in re-imaging of 63%. These findings are highly promising with regard to the long-term outcome for all patients in this regard and demonstrate the value of SGRT in general.

Moreover, in the completed surveys, 92% of the respondents reported a strong impact of PV on treatment quality and treatment efficiency, and 58% reported increased availability of treatment systems to patients. Efficiency, ease of use and time saving also dominate the free-text responses. RTTs report that PV is very valuable for extremities or when patients are difficult to position. In one case, where PV was removed for one fraction, the treatment time increased significantly (**see Supplementary File**).

There are several limitations in this study. All data was collected within the same network. Even if the contributing centers were selected to be as comparable as possible, a potential bias due to the same management structures can't be excluded. Anyway, the scope of this work was to evaluate the feature within this structure. Moreover, a larger sample size could provide stronger evidence. Finally, this study was performed from the perspective of a corroboration of a business case for our multicenter network. The combination of maintaining a high level of quality and consistency for clinical quality, safety and effectiveness together with the economic requirements in a large multi-center network might not be directly comparable with other clinics.

The results from this ROI study have provided quantitative data showing reduced reimaging and an increase for the linac capacity by one patient per 36 patients treated per day for SGRT with PV versus SGRT alone. This data is corroborated with sentiment from the clinical staff, demonstrating the enhanced accuracy and efficiency of patient setup with PV, and ultimately allowing an objective, business-focused assessment of the investment in PV.

Ethical approval

Ethical approval was not necessary for the preparation of this article.

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Conflict of interest

K.O. and N.S. declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. T.M. is with Vision RT GmbH.

Authors contribution

K.O.: conceptualization, methodology, project administration, writing — original draft, data collection; N.S.: data collection, methodology, proofreading; TM: data analysis, writing — editing — reviewing.

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