Evaluation of a Sinmed shoulder support cushion for head and neck immobilisation

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Abstract Purpose: Accuracy and reproducibility of patient positioning is a central issue in the successful delivery of radiation therapy treatment. As treatment techniques become increasingly conformal, this issue has become ever more important. With the recent implementation of Intensity Modulated Radiation Therapy (IMRT) for head and neck patients, the Princess Alexandra Hospital Radiation Oncology Department has been investigating optimal immobilisation techniques for these patients. Methods: As part of this investigation, the department has recently trialled the inclusion of a modified Sinmed shoulder support cushion (CIVCO Medical Solutions, Kalona IA, USA) as part of the standard positioning protocol for head and neck patients. After trialling this piece of equipment on a small group of patients, an evaluation was undertaken to assess its effect on patient positioning accuracy. This evaluation consisted of electronic portal imaging assessment and collation of observations from treatment and planning staff. Results: No major differences were found between the positioning accuracy achieved for patients positioned with the support cushion in comparison to those positioned as per departmental protocol. Furthermore, trends were noted that indicated the support cushion actually decreased the level of positioning accuracy that was achieved. Staff observation demonstrated that the support cushion was not easy to use and contributed to problematic shell fitting in daily practice. Conclusion: As a result, the shoulder support cushion has not been implemented as part of the department’s protocol for head and neck patient positioning with its use being limited to those patients who would most benefit from its inclusion due to anatomical restrictions.

Keywords: head and neck, immobilisation, radiation therapy.

Introduction

Accuracy and reproducibility of patient positioning has always been a cornerstone of the successful delivery of radiation therapy. As treatments become increasingly conformal and particularly with the advent of Intensity Modulated Radiation Therapy (IMRT), positioning accuracy has become ever more important. Immobilisation for patients receiving treatment to the head and neck area is a subject that has been particularly well documented. Li and his colleagues state that positioning accuracy is even more critical for patients with head and neck cancer due to the complexity of the anatomy and the proximity of tumours to many critical and radiation-sensitive structures. Consequently, accurate and reproducible immobilisation of the head and neck is an issue that can present a number of challenges. With the implementation of head and neck IMRT at the Princess Alexandra Hospital (PAH) Radiation Oncology Department, the issue of optimal positioning for these patients is being investigated and evaluated. As part of this process, the department recently trialled the use of a modified Sinmed Shoulder Support Cushion (CIVCO Medical Solutions, Kalona IA, USA) in conjunction...
to evaluate the inclusion of the shoulder support cushion in standard positioning could lack adequate support. In order to support provided for the back and shoulder region, an area with hypothesised that this could be achieved through increasing the support cushion.

Perception of the effectiveness of the new piece of equipment. Evaluation of verification images for patients treated with and without the inclusion of the support was performed as an indication of positioning accuracy and reproducibility. General observation also formed part of the evaluation in order to assess staff perception of the effectiveness of the new piece of equipment.

The inclusion of this piece of equipment in standard positioning was aimed to increase positioning accuracy as it is documented that immobilisation of the shoulders, as well as the head and neck, can decrease overall set-up uncertainties. It was hypothesised that this could be achieved through increasing the support provided for the back and shoulder region, an area with the standard positioning could lack adequate support. In order to evaluate the inclusion of the shoulder support cushion in standard patient set-up, an investigation was undertaken to assess its effect on positioning accuracy, reproducibility and ease of use.

This evaluation was undertaken by employing various methods. Evaluation of verification images for patients treated with and without the inclusion of the support was performed as an indication of positioning accuracy and reproducibility. General observation also formed part of the evaluation in order to assess staff perception of the effectiveness of the new piece of equipment.

The Princess Alexandra Hospital Human Research Ethics Committee was notified of the intent to publish the results of this quality improvement project. This notification was acknowledged on 28th June, 2010. As this evaluation was considered a quality improvement project, no further ethics approval was required.

Methods and materials

Patient selection

From August to September 2009, six consecutive head and neck patients were positioned with the inclusion of the shoulder support cushion. No specific inclusion criteria were set besides the patient requiring to be immobilised in a thermoplastic mask encompassing the head, neck and shoulder regions for a radical course of radiation therapy. It was also important that the patient could tolerate the inclusion of the support.

In order to establish a baseline for comparison, six patients receiving treatment to the head and neck region during the same period of time were randomly selected. These patients were positioned as per standard departmental protocol that was, without the support cushion.

The investigation only required an indication of the effectiveness of the positioning device therefore; a small number of patients were adequate. This information was required in a timely manner so that an informed decision could be made with regards to the permanent implementation of the shoulder support cushion.

Shoulder support cushion positioning

Standard positioning for the head and neck area involves patients lying supine on a Medtech shell board (CIVCO Medical Solutions, Kalona IA, USA), which is indexed to both the planning and treatment couches. A suitable headrest is chosen from a standard selection and fixed to the shell board. A thermoplastic mask encompassing the head, neck and shoulder areas is made and fixed to the shell board. A knee bolster, foot brace device and hand grips are used as additional positioning aids.

For patients positioned with the shoulder support cushion, a set of standard instructions were provided to planning and treatment staff as to the intended positioning of the shoulder support cushion. A notch of 17.5 cm x 4 cm was cut from the central superior section of the cushion. This notch was created in order to accommodate the Medtech headrest system (CIVCO Medical Solutions, Kalona IA, USA) already employed in the department. The shoulder support cushion was positioned on top of the Medtech shell board (CIVCO Medical Solutions, Kalona IA, USA) with the custom made notch abutting the inferior edge of a standard headrest (Figure 2). No additional fixation or indexing was employed in positioning the support cushion on the treatment couch. It is important to note that the department had purchased the support cushion previously and then modified it in order to use it in conjunction with our current immobilisation system. As such, it was not utilised as per the manufacturer’s original intention.

Analysis methods

Once the selected patients had completed their treatment, a retrospective assessment of field placement accuracy was conducted on both groups of patients. This assessment was carried out on electronic portal images (EPIs) taken throughout the course of treatment. Departmental protocol directs for EPIs to be taken on the first three fractions of a patient’s treatment. The departmental action level for head and neck patients is 3.0 mm. If on these first three fractions, displacements are less than 3.0 mm in magnitude, EPIs are then taken on a weekly basis for the remainder of treatment. When the displacements are greater than or equal to 3.0 mm, EPIs are taken on the subsequent two fractions to eliminate systematic errors.

Displacements between the treatment images and the associated reference image were recorded for the superior-inferior, left-right and anterior-posterior directions. These measurements were
performed on orthogonal sets of images only. The displacement values were calculated by employing the templating system available on iView GT (version 3.4, Elekta Ltd, Stockholm, Sweden). It is important to note that EPIs of three patients positioned using the shoulder support cushion were retrospectively assessed using the imaging tools on MOSAIQ (version 1.60, IMPAC Medical Systems, CA, USA) as their images had been removed from the iView GT database. Assessment of EPIs was conducted by one radiation therapist only. All EPIs of the six patients positioned without the support were retrospectively assessed on the iView GT system. Assessment of EPIs was conducted by one radiation therapist only. All EPIs of the six patients positioned without the support were retrospectively assessed on the iView GT system. Assessment of EPIs was conducted by one radiation therapist only. All EPIs of the six patients positioned without the support were retrospectively assessed on the iView GT system. Treatment images were matched to planning reference images using a best fit approach between the skull and cervical vertebrae 1–3 and 4–6.

The data collected was then analysed and the average displacement error in each direction for the entire course of treatment was calculated using a basic Microsoft Excel spreadsheet (Microsoft, Seattle WA, USA). The frequency of permanent isocentre shifts required to be made was documented and compared. A permanent isocentre shift was made if a shift of greater than or equal to 3.0 mm was performed in the same direction on at least three consecutive treatments. The frequency of displacements of 3.0 mm or more in any direction was also documented and compared.

No further statistical analysis was performed as the purpose of the evaluation was to obtain an indication of the magnitude of the effect the support cushion had on patient positioning and to ascertain whether this effect was beneficial or detrimental.

Once the trial period had been completed, staff working in both planning and treatment areas were asked to document and submit their observations regarding the use and effectiveness of the support cushion. Areas canvassed included ease of use, observed patient comfort and practicality of use.

Results

EPI assessment

In total, 194 EPIs were assessed for all patients, comprising of 80 images for patients positioned without the support and 114 images for those positioned with the support. The number of orthogonal image sets per patient that were analysed ranged from 6 to 12. This consisted of an average of approximately six image sets per patient positioned without the support and approximately nine images sets per patient positioned with the support.

Overall, no major differences in positioning accuracy were found between those patients positioned with the shoulder support cushion and those positioned without it (Figure 3). The mean displacement value in the superior direction was 1.8 mm for patients positioned as per standard protocol and 2.7 mm for those positioned with the shoulder support. In the inferior direction, the mean displacement value was 1.9 mm and 2 mm respectively. The maximum displacement value in the superior direction was 3 mm for patients positioned as per standard protocol compared to 7 mm for those positioned with the shoulder support. In the inferior direction, the maximum displacement values were 5 mm and 6 mm respectively.

Mean displacement in the left direction measured 1.6 mm for patients positioned as per standard protocol and 1.9 mm for those positioned with the shoulder support. In the right direction, mean displacement was 1.7 mm and 2.1 mm respectively. Maximum displacement in the left direction for patients positioned as per standard protocol measured 5 mm as compared to 4 mm for those positioned with the shoulder support. In the right direction the maximum displacement measured 2 mm and 4 mm respectively.

In the anterior direction, mean displacement measured 1.3 mm for patients positioned as per standard protocol and 2 mm for those positioned with the shoulder support. In the posterior direction, mean displacement was 2 mm and 1.7 mm respectively. Maximum displacement in the anterior direction was 3 mm for those positioned as per standard protocol as compared to 4 mm for patients positioned with the shoulder support. In the posterior direction, maximum displacement measured 5 mm and 4 mm respectively.

As demonstrated by these results, the predominant direction of displacement was in the superior-inferior direction with the maximum overall displacement being measured in the superior direction for a patient positioned with the shoulder support cushion. The fact that no major differences were noted between the two groups indicates that there was little to no benefit to set-up accuracy gained with the inclusion of the shoulder support cushion.

A trend toward decreased set-up accuracy and reproducibility was also indicated when the shoulder support cushion was included in patient positioning. This was demonstrated in both the number of permanent isocentre shifts required to be made during treatment and the frequency of displacements of 3 mm or more seen between planning reference images and treatment verification images (Tables 1 and 2).
Other observations from EPI assessment

In addition to the quantitative data collected, a number of observations were made on examination of the treatment verification and computed tomography (CT) images. It was discovered when studying the CT images of patients positioned on the support cushion that it created a bunching of posterior neck flesh in the gap between the inferior part of the headrest and the support cushion (Figure 4). It was observed in planning and treatment that this flesh bunching could be a result of the patient moving superiorly after initially laying on the couch in order to be correctly positioned on the headrest. This bunching of flesh was also visible on the treatment EPIs of these particular patients (Figure 5). It was not possible to absolutely quantify the amount of flesh that bunched in this gap or whether it was accurately reproduced on a daily basis.

Practical experiences and observations

As part of the evaluation, planning and treatment staff were asked to document and submit their experiences using the support.

Planning staff observations

As noted in examination of the CT and treatment images, planning and CT staff specifically noted the bunching of posterior neck flesh in the gap between the headrest and the support cushion. Attempts were made to try to avoid its occurrence; however, it was determined by planning staff that it could not be actively avoided. Another observation made by planning staff was that the inclusion of the support cushion was not appropriate for the majority of patients due to their anatomy and the general shape and size of the cushion. As such, it was only applicable for use in a small number of cases.

Treatment staff observations

Five treatment charge radiation therapists and a treatment senior radiation therapist provided a summary of feedback from their respective treatment areas regarding the use of the shoulder support. The primary observation made by treatment staff was the issue of inadequate fixation of the support cushion on the Medtech shell board. This lack of fixation led to inconsistencies in the exact positioning of the support in relation to the headrest. These small positioning differences resulted in large shell fit variations. It was noted that the inclusion of the support cushion introduced a large component of variability into the set-up and could make accurate and efficient shell fit problematic.

Similar to observations made by planning staff, treatment staff also noted that the shoulder support cushion was not suitable for use for all patients. It was observed as being particularly unsuitable for patients with hunched backs as it forced their chin to tilt in an uncomfortable manner.

A potential advantage of incorporating the shoulder support cushion in standard positioning was it could assist in reducing patient straightening issues with regards to the alignment of the face and neck. This observation was only applicable for patients who were suitable candidates for the inclusion of the shoulder support cushion in their set-up. It was hypothesised that this could be a result of increased patient comfort. The collected treatment verification images were analysed in order to attempt to validate this observation. However, due to the small patient sample studied, it could not be accurately substantiated.

Discussion

The success of highly conformal and dose escalation
techniques such as IMRT in radiotherapy is dependent upon accurate and reproducible patient positioning. Poor patient positioning can result in a geographic miss of the tumour volume and irradiation of surrounding healthy and critical tissues.

At the PAH Radiation Oncology Department, IMRT for patients receiving treatment to the head and neck has recently been implemented. Consequently, investigation has been undertaken into various techniques to optimise the positioning accuracy that can be achieved for this group of patients. This particular evaluation aimed to assess the effect on positioning accuracy of including a shoulder support cushion in our standard head and neck patient set-up. It was hypothesised that the inclusion of the shoulder support cushion could increase overall positioning accuracy for head and neck patients.

Factors that contribute to positioning uncertainty can be categorised into three main sources: the systematic difference between immobilisation at planning and treatment, the random set-up uncertainties in daily positioning and trends caused by anatomic variations or physiologic changes during treatment. Immobilisation systems aim to minimise the magnitude of random error that occurs throughout a patient’s treatment. However, for head and neck patients, the long target volumes in this region can mean that portions of the target can move very differently to each other. Additionally, there is the potential that individual anatomical regions can have different uncertainties.

There were no other studies discovered in the literature that investigated the effect of the shoulder support cushion on positioning accuracy; however, the issue of enhanced immobilisation for head and neck patients is an issue that has been well documented. Various studies have concluded that although isocentre positioning accuracy can be excellent due to sufficient immobilisation of the head region, inadequate immobilisation of the lower neck and shoulder area make positioning at this level more variable.

It has been reported in the literature that many commercially available head and neck immobilisation devices do not provide adequate stabilisation of the lower neck and shoulder area. This issue has also been noted by our department. As a result of this inadequate support, positioning accuracy at the shoulder level in comparison to the head region can be greatly reduced. The aim of including the shoulder support cushion as part of standard head and neck patient positioning was to improve overall positioning accuracy. However, it was found in our evaluation that this particular device did not improve overall patient positioning accuracy and furthermore, trends were identified that indicated it actually had a negative effect. Similar to results obtained in the literature, we also found that it was not always possible to predict or identify the patients who would experience set-up difficulties.

It is important to note the limitations of this particular evaluation. Only a small patient sample was used for this evaluation and the patient demographics of this sample were not recorded. This could introduce the potential of bias affecting the results obtained as it was not assessed whether the two patient groups were similar in their make up. As this assessment was non-blinded, bias could have also been introduced as the assessor was aware of which device each patient was positioned on. In addition, only one radiation therapist was involved in assessing patient verification images. However, as the purpose of the study was to evaluate a change in the department’s current practice, it was felt that this particular evaluation method was adequate to gain an indication of the effect of the shoulder support cushion on positioning accuracy. Any major differences in the frequency of positioning inaccuracy would also be detectable.

Another limitation of this evaluation was the lack of adequate fixation of the shoulder support cushion on the head and neck base board. Potentially, this was a contributing factor to the relatively poor results obtained for the support cushion, a point that must be taken into consideration when viewing these results. This issue was also highlighted in observations made by treatment staff that noted that this inadequate fixation contributed to problematic shell fitting. However, this fixation issue was not addressed as the overall evaluation demonstrated that there was little benefit gained from the inclusion of the shoulder support cushion.

Conclusion

As a result of the study, it was found that no real benefit was gained from the inclusion of the modified support cushion in the department’s current immobilisation system as opposed to standard head and neck patient positioning. Further, trends were noted that indicated the support cushion potentially decreased the accuracy and reproducibility of patient positioning. Additional observations also indicated that the shoulder support cushion further complicated patient set-up and was not suitable for all patients.

As a result of this evaluation, use of the shoulder support cushion has been restricted to those patients whom the staff in the CT planning session assess would benefit from its inclusion. The evaluation also highlighted the importance of performing regular verification imaging in order to assess positioning accuracy throughout treatment.

The author

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