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Patient positioning and treatment instructions used during radiation therapy of the prostate: results of an Australian and New Zealand survey

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Abstract National standards for patient positioning and treatment instructions for radiation therapy of prostate cancer are non-existent. To maximise daily reproducibility of the patient's position, immobilisation and stabilisation devices are often used. To minimise prostate motion, patients may be given instructions to regulate rectal and bladder volumes. However, the use of these patient positioning devices and the provision of patient treatment instructions vary between radiation therapy centres. In May 2003 a survey was sent to all radiation therapy chiefs throughout Australia and New Zealand requesting information regarding the treatment of prostate cancer patients. This comprehensive review of current practices clearly demonstrates differences between centres on the use of patient instructions to regulate rectal and bladder contents, however, stabilisation and immobilisation methods proved to be more consistent. The results will be discussed in light of the current international literature regarding patient positioning and patient treatment instructions used during radiation therapy of the prostate. This review has identified limited areas of consensus, and highlighted the need to develop common protocols and benchmarking of standards in order to improve treatment delivery.

Introduction

The prescribed dose to treat prostate cancer using external beam radiation therapy is limited by the dose toxicity to the surrounding organs – namely the rectum and the bladder, which are both mobile structures within the pelvis. Field placement errors occur due to a combination of patient set-up errors and internal organ motion. Patient set-up error is easily verified using port-films or electronic portal images (EPI). Internal organ motion is harder to verify and occurs when the planned volume of the bladder and/or rectum changes causing these structures to move into the planned treatment field, and consequently push the prostate out. Internal organ motion therefore impacts not only on toxicity but also on tumour control probability.[1–5]

There have been many studies on the relationship of bladder and rectal volumes to prostate organ motion.[4–16] The literature demonstrates a large range of effects caused by these volume changes. All of these articles agree that rectal volume and/or diameter has a large influence on the prostate position, and most agreed that there is a time trend associated with rectal volumes decreasing during a course of radiotherapy.[7] As the rectal volume decreases, the prostate gland has been shown to be pushed more posteriorly, and vice versa.[11,13,15] There is further debate over the influence of bladder volumes on prostate motion. Some published studies concluded that there was a decrease in bladder volume over time and that this change in volume influences prostate motion,[4,5,7] while others argued that bladder volume does not have a significant influence on prostate position.[3,11,16]

The conflicting results in the literature[4–16] over the extent to which bladder and rectal volumes influence prostate motion is possibly due to a lack of standard patient positioning practices and variations in the treatment instructions given to patients. Treatment instructions given to prostate cancer patients can include advice regarding bladder filling/emptying, rectal filling/emptying and diet, although often no instructions are given at all. This lack of consensus in patient positioning and treatment instructions in the literature results in conflicting data on the extent to which bladder and rectal volumes influence prostate motion thus making it difficult to compare previous studies and apply them to standard clinical practice. However, the selection of appropriate patient positioning and treatment instructions play an important role in minimising field placement errors.

The aim of this survey was to gain an insight into the current practices used in oncology departments throughout Australia and New Zealand for prostate positioning and treatment instructions. This survey will highlight the practices that are inconsistent to each department and indicate the areas in which further research is needed to work towards the standardisation of practice.

Method

In May 2003, a survey requesting information on the treatment of prostate cancer patients was sent to all chief radiation therapists across Australia and New Zealand. In September 2003 a reminder was sent to those who had not responded. The total time frame for the return of the surveys was five months.

Ethics approval was not obtained for this survey as it was not anticipated that there would be any ethical concerns because none of the questions related directly to patients. Completion and return of the questionnaire was taken to indicate consent to participate.

The survey requested that the chief radiation therapist, or their nominated representative, provide information regarding the treatment of prostate cancer patients including:

- *In what position are prostate patients treated?*
- *Are stabilisation/immobilisation devices utilised?*
- *What technique(s) is used to treat prostate patients?*
- *What is your current method of verifying patient position and field placement?*
- *What instructions are given to patients in your department with regards to bladder filling, rectal emptying and diet?*
- *How do you ensure that these instructions are adhered to?*
- *On what research are your instructions based?*
- *Has your department conducted its own trials to verify bladder and rectal volumes?*

Results

In what position are prostate patients treated?
Fig. 1: Patient treatment position.
Are stabilisation/immobilisation devices utilised?
Fig. 2: Stabilisation and immobilisation devices utilised.
What technique is used to treat prostate patients?
Fig. 3: Treatment technique used.
What is your current method for verifying patient position and field placement?
Fig. 4: Verification method and frequency of verification.
What instructions are given to patients in regards to rectal emptying?
Fig. 5: Rectal emptying instructions.
What instructions are given to patients in regards to diet?
Fig. 6: Patient diet instructions.
What instructions are given to patients in regards to bladder filling?
Fig. 7: Bladder filling instructions.
How do you ensure that patient instructions are adhered to?
Fig 8: Verification of patient compliance.
On what research are your instructions based?
Fig. 9: Evidence used to justify patient treatment instructions.

Discussion

Response rate

Nineteen of the thirty-four (56%) centres contacted responded to the survey. Despite the response rate being lower than expected, it is still considered to be a good rate of return for self-administered surveys[17] and the results collated still provide an insight into current practices throughout the region.

The survey questions can be broken down into two categories: those relating to patient positioning and those relating to treatment instructions.

1 Patient positioning

a. In what position are prostate patients treated?

The results indicate that there is a consensus throughout the majority of centres that the preferred patient treatment position is supine. Fourteen centres (74%) treat their patients supine, four (21%) treat them prone, and one (5%) centre utilises both supine and prone positions, citing radiation oncologist preference as the reason for two positions.

Treating patients in the prone position has been shown to decrease the volume of rectum within the treatment field, and subsequently reduces the dose to the rectum.[18–20] However, in the absence of immobilisation devices, the reproducibility of the prone position is less accurate possibly due to patient discomfort.[19] Recent literature suggests that patients prefer the supine position. Bayley *et al.*[21] conducted a randomised controlled trial to evaluate the optimal treatment position (supine vs. prone) for patients receiving radical radiation therapy for prostate cancer. The authors concluded that the supine position was significantly more comfortable for patients and, importantly, that the treatment set-up was significantly easier for radiation therapists. The consensus guidelines developed by the Faculty of Radiation Oncology Genitourinary Group (FROGG) as reported by Scala *et al.*[22] also recommend patients are treated in the supine position as it increases reproducibility. The FROGG recommendations were developed in collaboration with radiation oncologists, radiation therapists and medical physicists from Australia and New Zealand, during FROGG (Faculty of Radiation Oncology Genito-urinary Group) 3DCRT workshop in May 2002.

Bayley *et al.*[21] suggest that prostate motion in the anterior-posterior direction is significantly less in the supine position and requires fewer pre-treatment corrections than the prone position. Consequently the supine position generally achieves a decreased dose to critical structures.

b. Are stabilisation/ immobilisation devices utilised?

All but one (1/19) centre that responded to this survey use at least one stabilisation or immobilisation device for prostate treatment. Of the 14 centres that treat their patients supine, all (14/14) utilise either ankle or knee supports and eight (8/14) use a combination of these stabilisation devices (for example: knee supports and ankle supports.)

Effective immobilisation devices reduce inherent set up variability.[18,23–28] Catton *et al.*[28] demonstrated that leg cushions significantly reduced field placement errors compared to a non-immobilised set up, however, the proportion of errors greater than 5 mm was reported as up to 18%. Alpha cradles have been demonstrated to decrease the proportion of errors greater than 10 mm and reduce overall field placement errors to 1 mm compared to immobilisation using a leg cushion (3.2–3.4 mm).[18,24–25] Further improvements are seen in the anterior-posterior and superior-inferior directions using an aquaplast immoblisation device, however larger errors in the lateral direction were observed in more obese patients.[29]

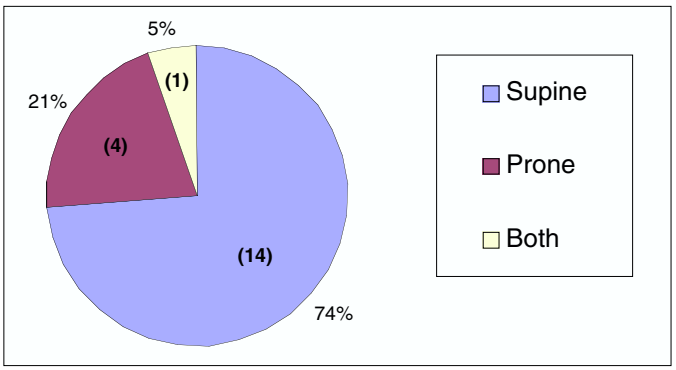

Fig. 1 Patient treatment position

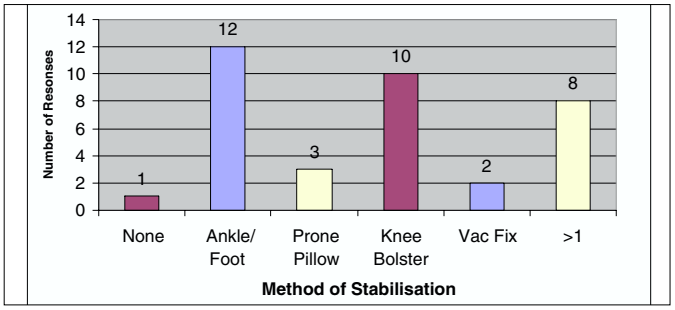

Fig. 2 Stabilisation and immobilisation devices utilised

Margins added around the clinical target volume (CTV) compensate for the effect of organ and patient movement and inaccuracies in patient set up.[30] Effective immobilisation allows the margins to be reduced, thus reducing volumes of normal tissues within the treatment field, consequently reducing normal tissue complication probabilities (NTCP)[18] and increasing tumour control probabilities (TCP).[31] Although the use of knee and/or ankle supports decrease patient set up errors compared to using no immobilisation, radiation therapy departments intending to undertake dose escalation studies may need to consider utilising improved patient immobilisation devices that reduce set-up error and allow the margins around the CTV to be reduced even further.

c. What technique is used to treat prostate patients?

There is a large variation in the technique used to treat prostate cancer patients, ranging from 3 to 7 fields and includes one centre which uses arcs. Although 13 (13/19) centres report using a four-field technique, many of these centres did not have one standard technique for all patients. Nine (9/19) centres reported using a combination of techniques.

The reasons given for the need to use multiple techniques included radiation oncologist preference and changes between phases to reduce critical organ dose.

Several articles have been published on the advantages and disadvantages of different field arrangements for the treatment of prostate cancer. Khoo *et al.*[32] evaluated the use of two three-field techniques (0º, 90º, 270º and 0º, 120º, 240º) compared to a four-field box technique (0º, 90º, 180º, 270º) and found that the three-field (0º, 90º, 270º) technique increased rectal sparing and reduced rectal NTCPs when escalating the dose delivered. Intensity modulated radiation therapy (IMRT) delivers the least dose to the rectum and improves dose conformity when compared to two-dimensional and three-dimensional (four-, seven- and ten-field) conformal plans.[33–34] Three-dimensional conformal plans have been shown to improve disease free survival and decrease treatment morbidity compared to standard radiation therapy.[35] When comparing four-, seven- and ten-field conformal plans, Dong *et al.*[33] found that the ten-field technique was superior, although the seven-field technique also produced acceptable doses to the critical structures and target volume. However, more complex field arrangements have only been introduced into clinical practice relatively recently and therefore it is too early to look at improvements in survival rates.

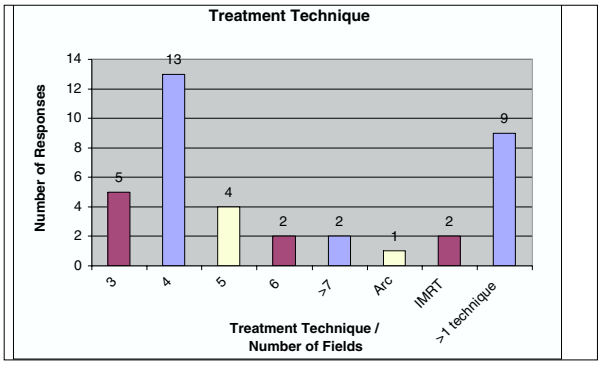

Fig. 3 Treatment technique used

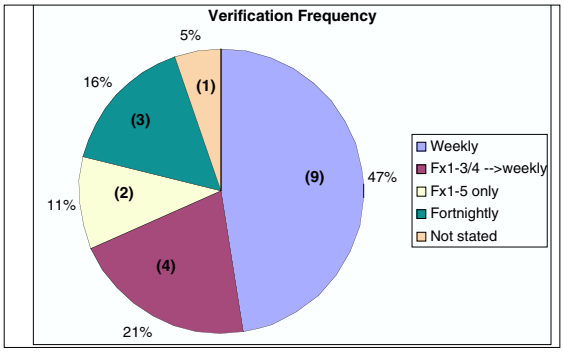

Fig. 4 Verification method and frequency of verification

d. What is your current method for verifying patient position and field placement?

All 19 (19/19) centres that responded to the survey indicated that they used either electronic portal imaging or port films to verify patient position and field placement, however, the frequency with which this verification was performed varied.

The majority of centres perform weekly orthogonal verification, although verification for the first five fractions, with or without weekly repeats, appears to be becoming more widely practiced. This change in practice may be due to the guidelines developed by FROGG. These guidelines state: 'As a minimum it is recommended that an isocentre check using AP and lateral films be acquired at least weekly during treatment, and ideally daily during the first week of treatment. If available, daily localisation with fiducial markers or ultrasound/CT imaging is preferred.[22]

This FROGG recommendation is based on the published literature that has recently focussed on the development of treatment verification protocols that are able to accurately correct for systematic errors with minimal imaging workload. Although field placement error is a result of random and systematic errors combined, it is widely accepted that systematic errors have the largest influence on accuracy.[36–37] 'Systematic error needs to be identified and corrected for as soon as possible during the first few fractions.[36] (p 226). The first five images were found to be a good estimate of the average systematic error over the entire course and could be used to correct subsequent fractions without the need for daily imaging, thus reducing workload.[36–37]

2 Patient treatment instructions

a. What instructions are given to patients in regards to rectal emptying?

Only four (4/19) centres give their patients specific instructions regarding rectal emptying. Two centres (11%) specified patients drink a fibre supplement, one (5%) asked patients to use suppositories and the remaining one (5%) asked patients to empty their rectum but provided no method by which this was achieved.

Theoretically, fibre supplements (such as Fybogel or Metamucil) or suppositories (Microlax) used during treat-

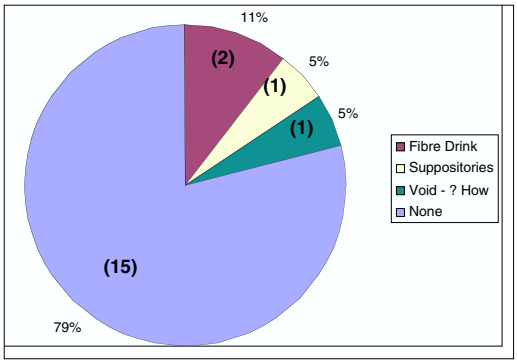

Fig. 5 Rectal emptying instructions

ment assist in maintaining a consistent rectal volume, although research specific to their use in radiation therapy is sparse. Human studies have shown that dietary fibre affects stool composition and consistency, however, most of the published studies found on the use of dietary fibre to regulate stool consistency relate to the treatment and/or prevention of faecal incontinence in elderly patients.[38]

Despite the lack of research specific to the use of fibre during radiation therapy, the consensus guidelines developed by FROGG[22] recommend that in order to maintain a constant rectal volume patients should be instructed to take a fibre bulking agent one week prior to their planning session, and cease only if bowel frequency develops (ie. continue throughout treatment). Therefore I would expect that, since this survey was completed, many centres may have already, or may be in the process of, reviewing their instructions regarding rectal emptying.

b. What instructions are given to patients in regards to diet?

Of the eight (8/19) centres that give their patients dietary instructions, three ask them to follow a low fibre diet, three to follow a low residue diet, one a balanced diet and one a high fibre diet.

Despite the literature acknowledging the effect of rectal volume on prostate position[4–16] (large rectal volumes push the prostate anteriorly), there is a lack of research specifically aimed at looking at how diet affects the daily rectal volumes of patients having radiation therapy. However, it is generally accepted that good nutrition will assist in the body's ability to repair healthy cells damaged by irradiation, thus reducing side effects. Kapkac *et al.*[39] have successfully shown this in rats, where fibre enriched diets effectively protected intestinal structure against radiation induced damage by improving mucosal integrity.

Liu *et al.*[40] completed a retrospective study of side effects reported by patients undergoing pelvic radiation therapy who had been given dietary instructions. Patients were encouraged to eat a low-residue diet and avoid spicy foods and alcohol. All of the patients who reported that they did not follow the dietary instruction at some stage throughout their treatment experienced side effects. However 'after they started or went back to the recommended diet, all problems subsided to various extents' (Liu *et al.*[40] p. 67). Improved dietary intake has also been shown to increase patient's self reported quality of life.[41] However, FROGG did not include dietary instructions in its guidelines.

Despite the lack of knowledge of the exact mechanisms by which fibre improves stool composition and consistency, and specifically a lack of research on the use of diet to maintain regular rectal volumes, the interpretation of the available literature suggests that rectal contents, and hence volumes, are influenced by the amount of fibre consumed in the diet. Since prostate organ motion is widely recognised as an important issue when designing radiation treatment margins, it is important that appropriate steps are taken to ensure the volumes are constant. Yet only half of the radiation therapy centres throughout Australia and New Zealand attempt to reduce this variation by supplying patients with information regarding diet or fibre supplements.

c. What instructions are given to patients in regards to bladder filling?

Fifteen of the 19 (15/19) centres that responded to the survey give their patients bladder instructions. However, there is no consensus on how much water patients should consume. Seven (7/19) centres asked patients to prepare for treatment by having a full bladder (3–4 glasses of water), six (6/19) asked them to drink 1–2 glasses of water (half full) and two (2/19) asked them to have an empty bladder. This lack of consensus reflects the lack of published literature that can reliably conclude whether treating these patients with an empty bladder is more reliable than treating patients with a full bladder, and vice versa.[4–16] The FROGG guidelines[22] recommend patients empty their bladder one hour prior to simulation or treatment and immediately consume two glasses of water.

It is also important to consider that bladder volumes may also vary depending on the weather (heat vs. cold), treatment reactions (de-hydration due to onset of diarrhoea), urinary frequency caused by radiation cystitis, timing of each treatment appointment (am vs. pm, and therefore how much fluid has been consumed during the day) and how accurately the patient measures the amount of fluid drunk each day (consistent cup size being used to measure water intake).

d. How do you ensure that patient instructions are adhered to?

Seventeen of the 19 (89%) centres provide their patients with at least one treatment instruction. Fifteen (15/19) of these

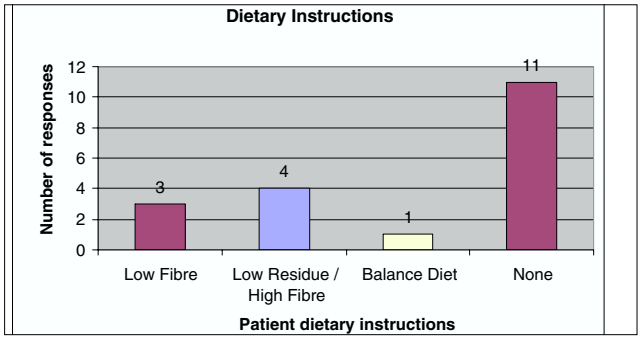

Fig. 6 Patient diet instructions

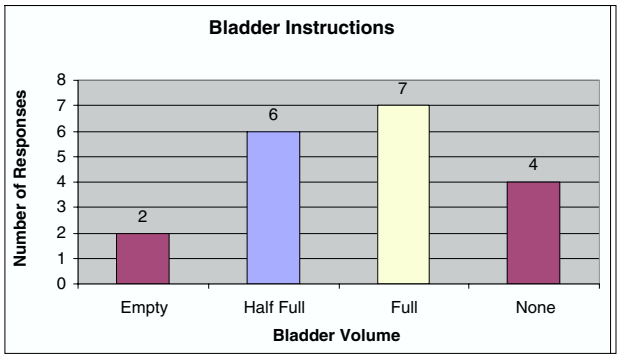

Fig. 7 Bladder filling instructions

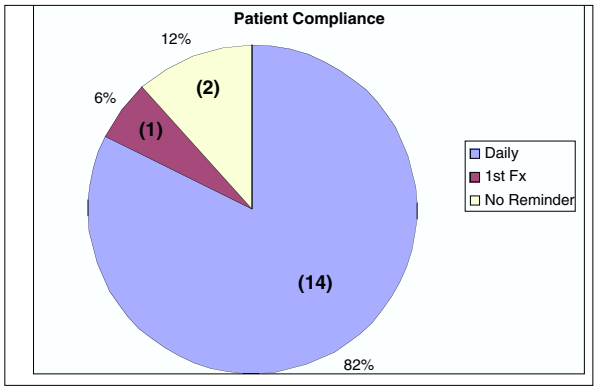

Fig. 8 Verification of patient compliance

centres responded that verification of patient compliance with the treatment instructions was the responsibility of the treatment staff, with variations on the frequency of these checks. Two (2/19) centres responded that no follow up with the patient was performed after the initial instructions were given.

Although treatment accuracy is compromised when patients do not comply with the treatment instructions they have been given, there are currently no quantitative methods used to verify on a daily basis that each patient has conformed to the instructions, or of assessing what affect any changes in these volumes have on the planned dose. In the absence of quantitative methods, treating radiation therapists must be diligent in verifying patients' compliance to treatment instructions.

e. On what research are your instructions based?

Remembering that 17 of the 19 centres provide their patients with at least one treatment instruction, when asked 'On what research were these instructions based?' six (6/17) of the responding centres said they did not know, four (4/17) stated results from the literature, four (4/17) stated experience and three (3/17) responded they followed the guidelines developed by FROGG.[22]

f) 'Is your department currently, or have they previously, conducted any trials to verify bladder and rectal volumes? Were they published?

Maybe as a reflection of the lack of conclusive research in literature, five of the 19 centres that responded have in the past, or are currently in the process of, conducting their own trials on various aspects of volume verification. Two (2/19) centres have researched the effect of bladder volume on bowel displacement, one (1/19) on field placement accuracy, reproducibility and volume analysis, one (1/19) on rectal volume variations and one on organ motion and immobilisation. However, at the time of the survey none of these trials were published.

Conclusion

This survey reviewed the current practices of 19 radiation therapy centres across Australia and New Zealand, and showed that stabilisation and immobilisation methods, along with a preference for treating patients supine, proved to be the most consistent aspects of treating prostate cancer patients. However, this review clearly demonstrates that there is no consensus between centres on the use of patient instructions to regulate rectal and bladder volumes despite the literature highlighting the effect these variables can have on treatment accuracy. The results also indicate that each centre, or even individual prescribing radiation oncologists, has developed its own preferences in regard to patient position and treatment instructions based on experience, possibly due to the lack of consensus in the published literature on the influence of bladder and rectal volumes on prostate motion.

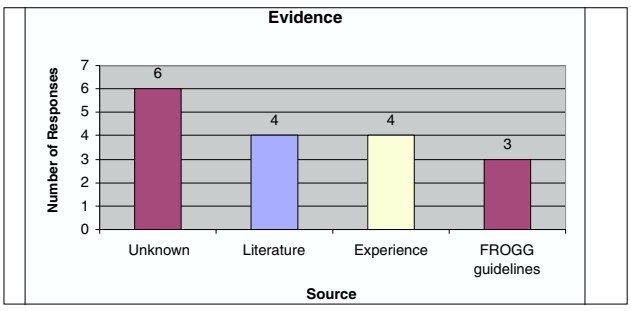

Fig 9 Evidence used to justify patient treatment instructions

One significant reason for this lack of consensus may be that, despite numerous studies in the literature,[4-16] there have been no common protocols on which they were based, making the comparison of results almost impossible. This lack of consistency is compounded by a lack of research specifically aimed at looking at the effect fibre supplements and diet have on rectal volumes and by the difficulty in ensuring patients comply with these instructions.

It is in each radiation therapy centre's interest to identify areas of consensus in practice to allow us to develop common protocols and benchmarking of standards. However, a lack of sufficient evidence in the literature on the impact of patient positioning and treatment instructions on patient survival and radiation induced complication rates has resulted in individual departments continuing to investigate their own practices rather than adopting a standard approach. Radiation therapy departments should be encouraged to implement randomised controlled trials to evaluate the efficacy of their treatment instructions and at the same time increase the body of evidence needed to develop standard protocols.

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