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Medical Policy Manual

Topic: Intensity Modulated Radiation Therapy (IMRT): Central Nervous System (CNS) and Vertebral Tumors

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IMPORTANT REMINDER

Medical Policies are developed to provide guidance for members and providers regarding coverage in accordance with contract terms. Benefit determinations are based in all cases on the applicable contract language. To the extent there may be any conflict between the Medical Policy and contract language, the contract language takes precedence.

PLEASE NOTE: Contracts exclude from coverage, among other things, services or procedures that are considered investigational or cosmetic. Providers may bill members for services or procedures that are considered investigational or cosmetic. Providers are encouraged to inform members before rendering such services that the members are likely to be financially responsible for the cost of these services.

DESCRIPTION

Radiation therapy is an integral component in the treatment of many brain tumors, both benign and malignant. Intensity modulated radiation therapy (IMRT) has been proposed as a method of radiation therapy that allows adequate radiation therapy to the tumor while minimizing the radiation dose to surrounding normal tissues and critical structures.

IMRT, which uses computer software and CT and magnetic resonance imaging (MRI) images, offers better conformality than 3D-CRT as it is able to modulate the intensity of the overlapping radiation beams projected on the target and to use multiple shaped treatment fields. It uses a device (a multileaf collimator, MLC) which, coupled to a computer algorithm, allows for “inverse” treatment planning. The radiation oncologist delineates the target on each slice of a CT scan and specifies the target’s prescribed radiation dose, acceptable limits of dose heterogeneity within the target volume, adjacent normal tissue volumes to avoid, and acceptable dose limits within the normal tissues. Based on these parameters and a digitally reconstructed radiographic image of the tumor and surrounding tissues and organs at risk, computer software optimizes the location, shape, and intensities of the beams ports, to achieve the treatment plan’s goals.

Increased conformality may permit escalated tumor doses without increasing normal tissue toxicity and thus may improve local tumor control, with decreased exposure to surrounding, normal tissues,

potentially reducing acute and late radiation toxicities. Better dose homogeneity within the target may also improve local tumor control by avoiding underdosing within the tumor and may decrease toxicity by avoiding overdosing.

Since most tumors move as patients breathe, dosimetry with stationary targets may not accurately reflect doses delivered within target volumes and adjacent tissues in patients. Furthermore, treatment planning and delivery are more complex, time-consuming, and labor-intensive for IMRT than for 3D-CRT.

MEDICAL POLICY CRITERIA

I. Intensity-modulated radiation therapy (IMRT) may be considered **medically necessary** for the treatment of tumors of the central nervous system.

II. IMRT for the treatment of vertebral tumors may be considered **medically necessary**.

SCIENTIFIC EVIDENCE

Background

Multiple-dose planning studies have generated 3D-CRT and IMRT treatment plans from the same scans, then compared predicted dose distributions within the target and in adjacent organs at risk. Results of such planning studies show that IMRT improves on 3D-CRT with respect to conformality to, and dose homogeneity within, the target. Dosimetry using stationary targets generally confirms these predictions. Thus, radiation oncologists hypothesized that IMRT may improve treatment outcomes compared with those of 3D-CRT. However, these types of studies offer indirect evidence on treatment benefit from IMRT, and it is difficult to relate results of dosing studies to actual effects on health outcomes.

Comparative studies of radiation-induced side effects from IMRT versus alternative radiation delivery are probably the most important type of evidence in establishing the benefit of IMRT. Such studies would answer the question of whether the theoretical benefit of IMRT in sparing normal tissue translates into real health outcomes. Single-arm series of IMRT can give some insights into the potential for benefit, particularly if an adverse effect that is expected to occur at high rates is shown to decrease by a large amount. Studies of treatment benefit are also important to establish that IMRT is at least as good as other types of delivery.

Literature Appraisal

Evidence from randomized controlled trials comparing intensity-modulated radiation therapy (IMRT) with other radiation techniques is needed in order to establish safety (e.g., toxicity) and efficacy (i.e., impact on clinical outcomes such as survival) of IMRT in the treatment of tumors of the central nervous system (CNS).

The available evidence on IMRT for treatment of tumors of CNS comes from observational studies (retrospective comparisons, single arm studies) with methodological limitations such as small sample sizes and heterogenous study populations. A significant number of the available studies are dose planing reports. Only a limited number of studies address clinical outcomes (e.g., overall survival, tumor control). These studies report inconsistent findings. However, the available studies consistently report

better sparing of healthy tissues and reduced toxicity in IMRT-treated patients.

High-grade Malignant Tumors

Systematic Reviews

Amelio and colleagues (2010) conducted a systematic review on the clinical and technical issues of using IMRT in newly diagnosed glioblastoma multiforme (GBM).[1] The articles included in the review were through December 2009 and included 17 studies (9 related to dosimetric data and technical considerations, 7 to clinical results, and 1 to both dosimetric and clinical results) for a total of 204 treated patients and 148 patient datasets used in planning studies. No randomized controlled studies (RCTs) were identified, and a meta-analysis was not performed.

For the 6 papers related to planning studies that compared either 3D-CRT versus IMRT, 1 study showed a noticeable difference between 3D-CRT and IMRT for the planning target volume (PTV) (13% benefit in V95 [volume that received 95% of the prescribed dose] from IMRT, $p<0.001$)[2]; the remaining studies suggested that IMRT and 3D-CRT provide similar PTV coverage, with differences between 0 and 1%. Target dose conformity was found to be improved with IMRT.

The organs at risk (OAR) typically under consideration in the studies were the brainstem, optic chiasm, optic nerves, lens and retina. In general, IMRT allowed better sparing of the OAR than 3D-CRT but with considerable variation from study to study.

The 8 studies that included clinical results included 3 retrospective, 1 prospective Phase I and IV prospective Phase II single institution studies. Of these 8 studies, 2 used conventional total dose and dose per fraction, 2 used a hypofractionated regimen, and in the remaining, a hypofractionated scheme using a simultaneous integrated boost. Chemotherapy was administered in 6 of 8 series, concomitantly with radiation and in the adjuvant phase. Median follow-up ranged from 8.8 and 24 months. Almost all patients (96%) were able to complete the treatment without interruption/discontinuation due to toxicity. Acute toxicity was reported as negligible with grade-3 side effects observed in only 2 studies at rates of 7% and 12%. Grade-4 toxicity was recorded in only 1 series with an absolute rate of 3%. Data for late toxicities were available in 6/8 studies, with 1 study recording grade-4 side effects with an incidence of 20%. One-year and 2-year overall survival (OS) varied between 30% and 81.9% and between 0% and 55.6%, respectively. When OS was reported as a median time, its value ranged from 7 to 24 months. Progression-free survival (PFS) ranged from 0% and 71.4% at 1 year and 0% and 53.6% at 2 years. Median PFS was reported as ranging from 2.5 to 12 months.

The authors also carried out a comprehensive qualitative comparison with data reported in the literature on similar non-IMRT clinical studies and offered the following conclusions. The results of the planning comparisons showed 3D-CRT and IMRT techniques provide similar results in terms of target coverage, IMRT is somewhat better than 3D-CRT in reducing the maximum dose to the OAR, although the extent varied from case to case, IMRT is clearly better than 3D-CRT in terms of dose conformity and sparing of the healthy brain at medium to low doses and that (in general) there were no aspects where IMRT seemed worse than 3D-CRT.

This evidence is limited by a number of factors. There is an absence of comparative studies with clinical outcomes, all of the studies were small in size, from a single institution, a majority of patients (53%) were retrospectively analyzed, and the administration of chemotherapy was variable across studies.

Primary Studies

A representative sample of the comparative studies on dose planning and the single-arm studies with clinical outcomes are discussed below.

- MacDonald and colleagues (2007) compared the dosimetry of IMRT and 3D-CRT in 20 patients treated for high-grade glioma.[3] Prescription dose and normal-tissue constraints were identical for the 3D-CRT and IMRT treatment plans. The IMRT plan yielded superior target coverage as compared with the 3D-CRT plan. The IMRT plan reduced the percent volume of brainstem receiving a dose greater than 45 Gy by 31% (p=0.004) and the percent volume of brain receiving a dose greater than 18 Gy, 24 Gy, and 45 Gy by 10% (p=0.059), 14% (p=0.015), and 40% (p< or=0.0001), respectively. With IMRT, the percent volume of optic chiasm receiving more than 45 Gy was reduced by 30.4% (p=0.047). As compared with 3D-CRT, IMRT significantly increased the tumor control probability (p< or=0.0005) and lowered the normal-tissue complication probability for brain and brain stem (p<0.033).

- Narayana and colleagues (2006) reported the outcomes of 58 consecutive patients with high-grade gliomas treated with IMRT.[4] GBM accounted for 70% of cases and anaplastic gliomas for the remainder. Surgery consisted of biopsy alone in 26% of patients and of those that underwent resection, 63% had total or near total resection and 37% had partial resection. Eighty percent of patients received adjuvant chemotherapy. Median follow-up was 24 months. Acute neurotoxicities were grade 1/2 in 36% of patients, grade 3 in 7%, and grade 4 in 3%. Late toxicities were grade 1/2 in 10%, grade 3 in 7%, and no grade 4 or 5. Freedom from late neurotoxicity at 24 months was 85%. Median OS for the anaplastic astrocytomas was 36 months and 9 months for the GBM group. From these data, the authors concluded that the use of IMRT in high-grade gliomas does not appear to improve survival

- Narayana et al.[4] also performed a comparison of the IMRT treatment plans with 3D plans performed in 20 patients out of 58 total in that case series. Regardless of tumor location, IMRT did not improve PTV target coverage compared to 3D planning. IMRT decreased the maximum dose to the spinal cord, optic nerves, and eye by 16%, 7%, and 15%, respectively. These data indicate that IMRT may result in decreased late toxicities.

- Huang and colleagues (2002) compared ototoxicity with use of conventional (2D) radiotherapy (n=11) versus IMRT (n=15) in 26 pediatric patients with medulloblastoma.[5] All of the patients also received chemotherapy. When compared to conventional radiotherapy, IMRT delivered 68% of the radiation dose to the auditory apparatus, but full doses to the desired target volume. Median follow-up for audiometric evaluation was 51 months (9-107 months) for the conventional radiotherapy group and 18 months (8-37 months) for the group that received IMRT. Thirteen percent of the IMRT group had grade-3 or -4 hearing loss, compared to 64% of the conventional radiotherapy group (p<0.014).

<u>Benign Tumors</u>

- Milker-Zabel and colleagues (2007) reported the results of the treatment of complex-shaped meningiomas of the skull base with IMRT in 94 patients.[6] Patients received radiotherapy as primary treatment (n=26) postoperatively for residual disease (n=14) or after local recurrence (n=54). Tumor histology was World Health Organization grade 1 in 54.3%, grade 2 in 9.6%, and grade 3 in 4.2%. Median follow-up was 4.4%. Overall local tumor control was 93.6%. Sixty-nine

patients had stable disease (by computed tomography [CT]/magnetic resonance imaging [MRI]), and 19 had a tumor volume reduction after IMRT. Six patients had local tumor progression on MRI a median of 22.3 months after IMRT. In 39.8% of patients, preexisting neurologic deficits improved. Treatment-induced loss of vision was seen in 1 of 53 re-irradiated patients with a grade-3 meningioma 9 months after retreatment with IMRT.

- Mackley and colleagues (2007) reported outcomes of treating pituitary adenomas with IMRT.[7] A retrospective chart review was conducted on 34 patients treated between 1998 and 2003 at the Cleveland Clinic. Median follow-up was 42.5 months. Radiographic local control was 89%, and among patients with secretory tumors, 100% had a biochemical response. One patient required salvage surgery for progressive disease, resulting in a clinical PFS of 97%. One patient who received more than 46 Gy experienced optic neuropathy 8 months after radiation.

- Sajja and colleagues (2005) reported the outcomes of 35 patients with 37 meningiomas treated with IMRT.[8] Tumor histology was benign in 35 and atypical in 2 tumors. The median CT/MRI follow-up was 19.1 months (range 6.4-62.4 months). Fifty-four percent of the meningiomas had been previously treated with surgery/radiosurgery prior to IMRT, and 46% were treated with IMRT, primarily after a diagnosis was established by CT/MRI. Three patients had local failure after treatment. No long-term complications from IMRT were documented among the 35 patients.

- Uy and colleagues (2002) assessed the safety and efficacy of IMRT in the treatment of intracranial meningioma in 40 patients treated between 1994 and 1999.[9] Twenty-five patients received IMRT after surgery either as adjuvant therapy for incomplete resection or for recurrence, and 15 patients received definitive IMRT after a presumptive diagnosis of meningioma on imaging. Thirty-two patients had skull base lesions and 8 had nonskull base lesions. Follow-up ranged from 6 to 71 months (median 30 months). Defined normal structures generally received a significantly lower dose than the target. The most common acute CNS toxicity was mild headache, usually relieved with steroids. One patient experienced Radiation Therapy Oncology Group (RTOG) Grade-3 acute CNS toxicity, and 2 experienced Grade 3 or higher late CNS toxicity, with one possible treatment-related death. No toxicity was observed with mean doses to the optic nerve/chiasm up to 47 Gy and maximum doses up to 55 Gy. Cumulative 5-year local control, PFS, and OS were 93%, 88%, and 89%, respectively.

Brain Metastases

- Edwards and colleagues (2010) reported outcomes on the use of whole brain radiotherapy (WBRT) with an IMRT boost in 11 patients with metastatic disease to the brain ranging from 25-80 mm in maximum diameter.[10] Patients were excluded if they had more than 4 metastases. Histologies of the metastases included primary lung (n=5), breast (n=4), colon (n=1), and kidney (n=1). There were no acute or subacute complications. All tumors showed response on a 1-month post-radiotherapy scan. Median follow-up was 4 months. Four of the 11 patients died of systemic disease 6-9 months after radiotherapy. The remaining patients were alive with no evidence of progression of the treated brain disease or local recurrence at 2-9 months after radiotherapy. No brain complications occurred to date.

Clinical Practice Guidelines

- The National Comprehensive Cancer Network (NCCN) guidelines state that "when radiation is given to patients with low grade gliomas, it is administered with restricted margins. Every attempt should be made to decrease the radiation dose outside the target volume. This can be achieved with 3-dimensional planning or IMRT."[11]

- NCCN guidelines do not address the use of IMRT in high-grade tumors or metastases of the CNS.[11]

Summary

Currently, there is no evidence from randomized controlled trials (RCTs) comparing intensity-modulated radiation therapy (IMRT) with other conformal radiation therapy modalities for treatment of CNS tumors. The available body of evidence for this indication consists of dose planning studies and case series. The case series are limited by lack of adequate comparison groups, small numbers, heterogeneous patient populations, and different types of tumors.

In general, the limited evidence suggests that IMRT provides tumor control and survival outcomes comparable to existing radiotherapy techniques. The evidence from treatment planning studies has shown that the use of IMRT decreases radiation doses delivered to critical CNS structures (e.g., optic chiasm, brainstem) and normal tissue adjacent to the tumor. This potentially lowers the risk of adverse events (acute and late effects of radiation toxicity), although the clinical benefit of reducing the radiation dose to critical structures and surrounding normal tissue using IMRT is theoretical. Determination of whether adverse event rates are reduced with IMRT is further complicated by a lack of high-quality literature defining the adverse effects using 3D conformal radiation therapy for the CNS, the main comparator to IMRT. The single arm case series are of limited usefulness in determining the benefits of IMRT over other conformal radiation modalities.

However, given the possible adverse events that could result when CNS structures receive toxic radiation doses, IMRT dosimetric improvements may be accepted as meaningful evidence for its benefit. Therefore, IMRT may be considered medically necessary for the treatment of tumors of the central nervous system and for vertebral tumors due to proximity to the spinal cord.

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CROSS REFERENCES

Intensity Modulated Radiation Therapy (IMRT) of the Thorax, Medicine, Policy No. 136

Intensity Modulated Radiation Therapy (IMRT) of the Prostate, Medicine, Policy No. 137

Intensity Modulated Radiation Therapy (IMRT) of the Head and Neck, Medicine, Policy No. 138

Intensity-Modulated Radiation Therapy (IMRT) of the Abdomen and Pelvis, Medicine, Policy No. 139

CODES	NUMBER	DESCRIPTION
CPT	77301	Intensity modulated radiotherapy plan, including dose volume histograms for target and critical structure partial tolerance specification
	77338	Multi-leaf collimator (MLC) device(s) for intensity modulated radiation therapy (IMRT), design and construction per IMRT plan (new code 1/1/10)
	77418	Intensity modulated treatment deliver, single or multiple fields/arcs, via narrow spatially and temporally modulated beams, binary dynamic MLC, per treatment session
	0073T	Compensator-based beam modulation treatment delivery of inverse planned treatment using three or more high resolution compensator convergent beam modulated fields, per treatment session

CODES	NUMBER	DESCRIPTION
HCPCS	None	