(PDI) for ten of the plans, and by independent dose calculation checks using RadCalc (RadCalc Version 6.2, LifeLine Software Inc, Tyler, USA).

Results: The observed differences between the conventional and the IMRT plans were limited. In average the maximum dose was 0.3 percentage points (pp) lower for IMRT than for conventional plans. The ITV coverage was better for the IMRT plans, with an average ITV minimum dose of 95.9 % compared to 94.1% (+1.8 pp). However, the PTV coverage was slightly worse for the IMRT plans, a decrease of 0.4 pp in V95%. The only relevant organs at risk are the lenses, were the maximum dose on average were lowered 0.3 Gray and the mean dose on average was lowered 0.1 Gray. The average HI for the IMRT plans was 4.0 while 5.1 for the conventional plans. The 10 PDI measurements were all accepted with a reference gamma index value of 5% dose agreement within 3 mm distance to agreement, and no further measurements were performed. Independent dose calculation checks were performed for QA. The time spend on treatment planning was approximately 20 minutes for IMRT plans and could easily be up to 3 hours when using the conventional technique.

	Property	Conventional	IMRT	Difference (Conv. – IMRT)
BODY	Maximum dose	106.4 %	106.1 %	-0.3 pp
ITV coverage	Minimum dose	94.1 %	95.9 %	+1.8 pp
PTV coverage	V95%	99.6 %	99.2 %	-0.4 pp
Lenses	Maximum dose	4.0 Gy	3.7 Gy	-0.3 Gy
	Mean dose	2.8 Gy	2.7 Gy	-0.1 Gy
Homogeneity	D5% / D95%	5.1	4.0	-1.1

Conclusion: It was possible to significantly reduce the time spend on dose planning by changing the treatment technique from conventional to IMRT for PCI patients while attaining comparable dosimetric quality of the treatment plans. Furthermore, both the treatment time and the time spend on quality assurances are comparable for the two techniques.

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Stereotactic body radiation therapy using Tomotherapy for refractory metastatic bone pain: case study

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Purpose or Objective: To illustrate the technique and outcome of stereotactic body radiation therapy (SBRT) using Tomotherapy for refractory bone pain from metastatic disease. Tomotherapy SBRT planning parameters and dosimetric evaluation are outlined.

Material and Methods: In 2013, a 70 year old female patient presented with metastatic non-small cell lung carcinoma, following resection of lung primary in 2012. CT and MRI confirmed a lytic lesion on right of sacrum. Patient's sacrum initially treated with 30Gy/10Fx. Pain recurred 2 months post RT and managed by palliative care. 6 months post RT patient returned for consideration of re-treatment. Pain was refractory to everything apart from 15mg of oxycodone every hour. RO discussed the patient and risks of re-irradiation within the multidisciplinary setting. The consensus was to offer the patient SBRT, 24Gy in 3 fractions to the sacrum.
Helical Tomotherapy was used to plan and treat patient. The irregular PTV volume was 201.12cm3. Dose volume constraints included: colon (0.035cc<18.4Gy, 20cc<14.3Gy), sacral plexus (0.035cc<11Gy, 5cc<7Gy), cauda equina (0.035cc<16Gy, 5cc<14Gy), and skin (0.035cc<26Gy, 10cc<23Gy). No hotspots were to be located over the nerve roots.

Results: Tomotherapy planning parameters included field width of 2.5cm, pitch of 0.2 and a modulation factor of 1.5. Beam on time was 400.3 seconds. PTV coverage statistics were D99 = 22.5Gy (93.75%), V95 = 98.57%, VTD = 90.53%, Median = 25.37Gy (105.71%), D1 = 27.8Gy (115.83%). OAR dose included colon 0.035cc = 8.1Gy, 20cc = 6.8Gy; sacral plexus 0.035cc = 27.3Gy, 5cc = 25.3Gy; cauda equina 0.035 = 26.2Gy, 5cc = 21Gy; skin 0.035cc = 15.4Gy, 10cc = 12.3Gy. The conformity index statistics were R100% = 0.97, V105% outside PTV = 2cc, R50% = 4.21, Dmax > 2cm from PTV = 16.45Gy (68.5%).
One week post SBRT, patient's pain stable and mobility improving. Whole body bone scan 2 months post SBRT showed decreased activity and size of sacral lesion. 4 months post SBRT patient returned with significant left sacral pain with concern of further metastatic disease. PET confirmed no uptake in left sacrum. Pain associated with insufficiency fracture with cause unknown, SBRT or bone metastasis likely contributors. 5 months post SBRT patient improved dramatically, completely ambulant with PET/CT showing no evidence of recurrence/metastatic disease. 13 months post SBRT, patient remains asymptomatic, CT shows no evidence of metastatic disease.

Conclusion: This case study illustrates how the use SBRT can result in pain control for patients with refractory metastatic bone pain where there may be no other options available apart from palliative care, even in cases where the treatment volume is relatively large. This data is also informative since the patient shows no definite evidence of metastatic disease. Further studies could lead to improved therapies for the control of metastatic bone pain.

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A decision protocol to propose proton versus photon radiotherapy: in silico comparison

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Purpose or Objective: Proton therapy cancer treatment offer potential clinical advantages compared with photon radiation therapy for many cancer sites. However, the treatment cost with proton is much higher than with conventional radiation. The objective of this study is to discuss how to improve a procedure, already described by others worldwide, to provide quantitative clues to select the patient for proton treatment instead of photon.

Material and Methods: The respective medical and clinical benefits of proton and photon therapy are assessed by in silico comparison following four successive steps. First, the dosimetric analysis is made using parameters derived from dose volume histogram (DVH) for target volume and organs at risks. Second, the DVHs are exported from TPS to calculate TCP and mostly NTCP radiobiological indexes. In the third step, a statistical comparison is done using non-parametric test to calculate p-value, then bootstrap method is used to estimate the confidence intervals including the lower and upper limit of agreements. Then the correlation between data from proton and photon treatment planning is assessed using Spearman's rank test. Finally, the cost-effectiveness and quality adjusted life years (QALYs) can be used to measures the outcome of the therapy and check if the therapeutic gain of proton therapy worth the increased expenses of it versus photon.

Results: The results with in silico data can be taken into account to make a proposal of a decisional procedure. The dosimetric and radiobiological analysis can be used to check the medical benefit with either proton or photon. The statistical tests allow to check if the dosimetric or radiobiological benefits for a specific patient can be included in the confidence interval of agreement of a representative population, the most homogenous possible. A Markov model can be used to simulate the life of patients treated with proton / photon radiation. The virtual evaluation may indicate for which cancer sites proton therapy could be more cost-effective than photon therapy.

Conclusion: The introduction of model based clinical trials with the possibility of individual assessment is a coming approach well adapted to the fast improvement of medical technology. The presently rising offer of proton therapy is a good example. The QALY concept based on objective dosimetric and clinical expected / modelized outcome may be a valuable response to this new challenge. However, large