

Physics Contribution: Clinical Physics

Predictive Parameters of CyberKnife Fiducial-less (XSight Lung) Applicability for Treatment of Early Non-Small Cell Lung Cancer: A Single-Center Experience

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Received Jan 3, 2013, and in revised form Jun 18, 2013. Accepted for publication Jun 19, 2013

Summary

The aim of this study was to determine factors predicting the use of CyberKnife fiducial-less soft-tissue tracking for stereotactic body radiation therapy for early-stage lung cancer. Tumor size, volume, and density were found to be the most predictive of the direct soft-tissue tracking possibility.

Purpose: To determine which parameters allow for CyberKnife fiducial-less tumor tracking in stereotactic body radiation therapy (SBRT) for early-stage non-small cell lung cancer.

Methods and Materials: A total of 133 lung SBRT patients were preselected for direct soft-tissue tracking based on manufacturer recommendations (peripherally located tumors ≥ 1.5 cm with a dense appearance) and staff experience. Patients underwent a tumor visualization test to verify adequate detection by the tracking system (orthogonal radiographs). An analysis of potential predictors of successful tumor tracking was conducted looking at: tumor stage, size, histology, tumor projection on the vertebral column or mediastinum, distance to the diaphragm, lung-to-soft tissue ratio, and patient body mass index.

Results: Tumor visualization was satisfactory for 88 patients (66%) and unsatisfactory for 45 patients (34%). Median time to treatment start was 6 days in the success group (range, 2-18 days) and 15 days (range, 3-63 days) in the failure group. A stage T2 ($P = .04$), larger tumor size (volume of 15.3 cm^3 vs 6.5 cm^3 in success and failure group, respectively) ($P < .0001$), and higher tumor density (0.86 g/cm^3 vs 0.79 g/cm^3) were predictive of adequate detection. There was a 63% decrease in failure risk with every 1-cm increase in maximum tumor dimension (relative risk for failure = 0.37, CI = 0.23-0.60, $P = .001$). A diameter of 3.6 cm predicted a success probability of 80%. Histology, lung-to-soft tissue ratio, distance to diaphragm, patient's body mass index, and tumor projection on vertebral column and mediastinum were not found to be predictive of success.

Conclusions: Tumor size, volume, and density were the most predictive factors of a successful XSight Lung tumor tracking. Tumors > 3.5 cm have $\geq 80\%$ chance of being adequately visualized and therefore should all be considered for direct tumor tracking. © 2013 Elsevier Inc.

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Conflict of interest: none.

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無對位標記電腦刀 (XSight 肺部腫瘤追蹤系統) 對早期非小細胞肺癌治療的可行性之預測性因素：單一中心之經驗

摘要(Summary)

這項研究的目的為確立在立體定位放射線治療上使用電腦刀無對位標記的軟組織追蹤系統對早期肺癌的預測因素。腫瘤的尺寸、體積及密度被認為是直接軟組織追蹤系統可能性中最能被預測的。

目的 (Purpose)

為確立哪些因素可允許電腦刀無對位標記軟組織追蹤系統用在對早期非小細胞肺癌的立體定位放射線治療(SBRT)。

方法及材料 (Methods and Materials)

依據製造商的建議 (周圍型腫瘤有著密集的外觀大於等於 1.5 公分) 及員工過去的經驗，共有 133 名 SBRT 病人預選做為直接軟組織追蹤系統的對象。病人先接受腫瘤影像測試來以驗證追蹤系統能提供足夠的檢測 (正交片)。成功的腫瘤追蹤系統潛在預報的分析是依腫瘤階段、大小、組織學、脊柱或縱隔膜的腫瘤投影、至橫隔膜的距離、肺部跟軟組織的比例和病人的身體質量來進行研究。

結果 (Results)

腫瘤可視化的結果為 88 名病人(66%)符合要求及 45 名(34%) 不符合要求。治療開始的時間中位數在成功組為 6 天(範圍, 2-18 天)和在失敗組為 15 天(範圍, 3-63 天)。在 T2 期時 ($p=0.4$), 較大的腫瘤尺寸(分別在成功組和失敗組, 體積為 15.3 立方公分 跟 6.5 立方公分) ($P<0.0001$), 及高密度的腫瘤(每立方公分 0.86 公克和每立方公分 0.79 公克)為可被預測的有行檢測。腫瘤最大尺寸每增加 1 公分, 失敗風險減少 63% (相關失敗風險等於 0.37, $CI=0.23-0.60$, $P=0.001$)。直徑 3.6 公分預測成功的機率為 80%。組織學、脊柱或縱隔膜的腫瘤投影、至橫隔膜的距離、肺部跟軟組織的比例和病人的身體質量並無預測成功。

結論 (Conclusion)

腫瘤的尺寸、體積和密度為 XSight 肺部腫瘤追蹤系統最能預測成功的因素。腫瘤大於 3.5 公分有至少 80%的機會使其影像可視化, 所以應將所有案例列入直接腫瘤追蹤系統的考量。