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可回收下腔静脉滤器放置与并发症关系的研究进展

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摘　要

可回下腔静脉滤器在临床应用越来越广泛，而滤器留置并发症得到越来越多的关注。可回收滤器放置时的相关因素可能造成滤器血栓形成、移位、回收困难等并发症。本文通过回顾文献，总结归纳了包括滤器品牌、放置入路、腔静脉直径、放置倾斜角度、滤钩距离肾静脉距离、滤钩开口朝向、滤钩开口方向与钩－倾的关系等滤器放置相关因素与延迟并发症之间的关系。以指导放置下腔静脉滤器时避免或纠正危险因素，提高回收率、减少并发症。

关键词

可回收下腔静脉滤器，放置，影响因素，并发症

Research Progress on the Relationship between the Retrievable Inferior Vena Cava Filter Placement and Complications

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Abstract

Retrievable inferior vena cava filters are becoming more and more widely used in clinical practice, and the complications of filter placement are receiving more and more attention. Factors related to the placement of retrievable filters may cause complications such as filter thrombosis, displacement, and difficulty in retrieval, etc. By reviewing the literature, this article summarizes the relationship between filter placement-related factors and delayed complications, including the brand of the filter, the placement access, the diameter of the vena cava, the angle of tilt, the distance of the filter hook from the renal vein, the orientation of the opening of the hook, hook direction, and hook-tilt relationship. To guide the avoidance or correction of risk factors when placing inferior vena cava filters, to improve the recovery rate and to reduce complications.

Keywords

Retrievable Inferior Vena Cava Filter, Placement, Risk Factors, Complications

1. 前言

随着血管外科的发展，以及临床医生对下肢深静脉血栓(Deep Venous Thrombosis, DVT)和肺动脉栓塞(Pulmonary Embolism, PE)疾病危害性的重视，一种可以有效预防肺栓塞发生的装置即下腔静脉滤器的置入一直在增加[1]。目前各指南对于下腔静脉滤器置入适应症存在争议，但对于急性 DVT 且存在抗凝禁忌的病人，大部分指南统一推荐可置入下腔静脉滤器预防肺栓塞[1] [2]。有研究证明永久滤器可能与下腔静脉血栓形成、血栓形成后综合征等并发症相关，同时永久滤器的置入因需长期口服药物可能给病人带来经济和心理负担[3] [4]。故而对于仅短期需要滤器保护患者可选择具有便利性和可操控性优点的可回收滤器。可回收滤器置入后仍存在延期并发症包括腔静脉穿孔、滤器移位、肺血栓栓塞、滤器血栓形成、倾斜、回收困难、滤器断裂等[2] [5] [6]。滤器倾斜可能影响滤器的捕获血栓效能，甚至对回收造成一定困难，回收时处理各种并发症也会给患者带来更多辐射暴露和经济压力[7] [8]。既往对于滤器放置因素与回收并发症的关系尚无文献总结。本综述通过总结既往文献，探索及归纳可能造成滤器倾斜、回收困难等并发症的因素，从而指导临床，以减少并发症发生，提高回收率。

2. 相关定义

滤器倾斜定义为：滤器长轴相较于放置段腔静脉长轴的偏转角度。倾斜角度 ≥15˚定义为严重倾斜或者有意义的倾斜。滤器移位定义为滤器头端或尾端移动超过 2 cm [1]。钩肾静脉距离定义为滤钩相对于最下肾静脉开口下界的距离。滤钩开口方向定义为正位透视造影下向左，向右或前后钩朝向。钩开口－倾斜状滤钩的关系定义为滤钩开口与倾斜钩状倾斜的关系分钩开口与倾斜方向相同或相反，钩开口朝前后无论左右倾斜，无倾斜等。滤器穿透定义为滤腿超过腔静脉壁 3 mm。困难回收定义为无法通过常规圈套技术回收滤器需要使用辅助技术[5] [7] [9]。

3. 滤器放置因素

3.1. 可回收滤器设计及品牌

随着滤器 50 年的发展，可回收滤器设计不尽相同，改进设计主要目的均是为了有效拦截血栓、减少并发症、提高回收率等，按形状主要分为梭形及伞形滤器。目前市场上常用的可回收梭形滤器有：OptEase；Aegisy；Illicium。常用的可回收伞型滤器包括：Günther Tulip Filter (GTF)；Celect；Denali；Option [5] [10]。目前对于不同滤器高质量的随机对照研究较少且研究品牌种类局限，多为回顾性观察性研究。不同滤器的设计有自己独特特色。

对于梭形滤器，由于支撑杆与腔静脉壁线性接触，有较大的接触面积，相较于伞型滤器的点接触，梭形滤器更容易产生新生的内膜包埋滤柱，超期回收时更易造成腔静脉壁损伤，故而梭形滤器回收窗口期一般为 12 天[5] [11] [12]。当然，尽管有不少超期成功回收的病例报道，但考虑到腔静脉壁损伤等并发症带来的二次危害，术前 CT 评估超期梭形滤器难度是合理的[13] [14]。

下腔静脉滤器释放后对腔静脉壁产生径向支撑力，从而可使滤器可锚定于放置位置，对于伞形滤器来说，滤腿锚定末端与腔静脉壁“点”接触相较于梭形滤器锚定滤柱与腔静脉壁的“线”性贴合更具有穿透性，有更高的穿透率，各研究报道存在差异，最高达到 86%，而滤器穿透可能造成腹痛症状[15] [16]。但不同的伞形滤器品牌，穿透率亦存在差异，有研究发现，与 ALN 滤器相比，Bard G2、Bard G2X 和 Cook Celect 滤器显示出更高的穿透率[17]。McLoney 等也报道了 Günther Tulip (43%)滤器和 Celect (49%)滤器的穿孔透率高于 Greenfield (2%) [18]。Han 等通过随机对照研究也发现 Celect 滤器穿透率(20.6%)显著高于 Denali 滤器(1.5%) [19]。当然滤器穿透除了与滤器设计、品牌有关外还可能与腔静脉直径及倾斜角度等有关[20]。

据报道，相较于伞形滤器，OptEase 梭形滤器的破裂率较高(38%)。滤器折断似乎与其制成金属特性相关，梭形 OptEase 滤器为镍钛合金，金属抗疲劳性可能相对差。造成滤器折断关键因素是超长的留置时间，随着时间延长折断发生率增加，可能是因各种金属被腐蚀、金属抗疲劳性能逐渐变差有关。当然，随着不同材料的研究，折断率逐渐下降。另外我们猜测梭形滤器因其更易产生腔静脉壁内膜增生包裹滤柱，回收时可能需要更大的推送回收鞘的力量才可收纳进回收鞘，这种操作增加了滤器折断裂解的潜在危险性[16] [21] [22]。

目前关于不同类型可回收滤器预防肺栓塞的有效性的对比性研究尚不足。Angel 等回顾分析了 37 篇文献共 6834 名患者，报道了可回收滤器置入后肺栓塞总体复发率为 1.7%，复发率最高的滤器为 Option (4%)，最低为 ALN 滤器(0.7%) [23]。Han 等通过随机对照试验证明 Denali 滤器与 Celect 滤器均能有效预防肺栓塞，且复发率无显著差异[19]。

几乎所有不同设计的滤器均存在倾斜问题，各研究中心纳入研究滤器不同，且多为回顾性研究，各种滤器的回收倾斜角度对比结果存在异质性，但可确定的是不同下腔静脉滤器的设计对回收时倾斜角度存在影响[24] [25]。Bae 等通过倾向性匹配分析了 Denali 滤器与 Celect 滤器回收时倾斜角度的差异，得出 Celect 滤器倾斜角度大于 Denali 滤器倾斜角度的结论[26]。一些随机对照研究也表明 Denali 滤器相较于 Celect 滤器，似乎有较小的回收倾斜角度及严重倾斜率[19] [27]。

Gotra 等回顾分析了 447 个滤器，包括 Argon Option Elite、ALN、Bard G2、Bard G2X、Cook Celect、Cook GT、Cordis OptEase 滤器，比较了它们从置入到回收的位置参数变化，其中 OptEase 梭形滤器位移变化最大，常向远心端的移位，这与其纺锤型结构设计相关，其结构很好适应腔静脉管型构造，但容易随着血管长轴平行移动，更容易引起移位[28]。Ayad 等的回顾分析发现梭形滤器更容易导致腔静脉血栓形成[22]。Usoh 等通过分析滤器置入后随访发现，TrapEase 梭形滤器比 Greenfield 滤器显示出更高的血

栓形成风险[29]。这可能与该类设计滤器的倒锥形设计有关，将血栓边集到靠近腔静脉壁，更易于形成血栓[30]。

尽管不同设计可能涉及以上并发症，但滤器品牌对滤器回收困难似乎并无直接相关性[9] [31] [32] [33]。每种滤器设计均有自己的特点，在置入时应该考虑到这些特点，本研究尚无法确定某款滤器的绝对优势。未来需要多中心、大规模、随机对照试验提供更多不同滤器设计的对比性研究，为临床提供更可靠的证据。

3.2. 静脉入路

下腔静脉滤器置入路径常常有多个选择，不同的置入路径因为解剖因素可能会造成不一样的影响。常见下腔静脉滤器置入的入路有股静脉、颈内静脉，经颈内静脉置入可能存在严重穿刺并发症，故而不是首选，当双侧髂、股静脉均有血栓或下腔静脉内存在血栓时，则考虑选择颈内静脉[5] [34]。

不同放置入路对滤器倾斜存在影响。Cohen 等发现颈静脉入路放置滤器倾斜角度小于股静脉入路[25]。而 Hodgkiss-Harlow 等认为不管是透视还是血管内超声辅助下置入下腔静脉滤器，相较于左侧，右侧股静脉入路是减小倾斜角度和减少释放位置错位的发生的更优选择[35]。Matsui 等通过体外模型经股静脉置入滤器及临床回顾分析经股静脉置入滤器的 21 例患者，得出 Günther Tulip 滤器在输送到预放置位置时与腔静脉的夹角即预放置倾角大小显著影响了放置后倾角[36]，这可以解释右侧股静脉相较于左侧股静脉为更优选择。因解剖上来说左侧髂总静脉入路与腔静脉夹角通常大于右侧，故而通常左侧股静脉入路的预放置倾角大于右侧，而颈内静脉入路距离预放置位置通常为肾静脉开口以下，存在较长距离，输送鞘末端更游离从而可通过微调使得预放置倾角减小[37]。xiao 等通过随机对照研究也证实了通过弯曲输送鞘减小预放置倾角，可显著减小放置后倾斜角度[38]。最近 Grullon 等回顾分析了 13,321 例患者，也证明了颈静脉入路的放置倾角显著小于股静脉入路[39]。虽然 Kleedehn 和 White 等通过单中心回顾性研究均认为放置时倾角与复杂回收无直接相关性，但与回收时倾角呈正相关[9] [40]，从而我们猜测减小放置倾角，可减小回收倾角，减小回收难度。然而，Choi 等回顾分析了 68 例置入 Denali 滤器的患者回收前 CT 影像，通过测量右侧颈内静脉、左侧股静脉、右侧股静脉入路的倾角，发现三条入路倾角无统计学差异，同时研究指出贴壁率三条入路也无统计学差异，这可能与样本量小有关，亦可能与 Denali 滤器辅助滤腿离滤钩近且凸出主体，保持滤器置入后稳定性有关[41]。

当然也有研究表明腘静脉入路亦可以安全准确放置滤器，Kim 等通过小样本的研究发现，经腘静脉置入可以减少额外穿刺点，从而减少患者不适感，但这种入路也存在滤器倾斜的问题，且对输送鞘要求足够长[42]。对于不同入路的滤器滤器回收时间存在差异，左侧股静脉入路放置的滤器回收透视时间显著多于右侧股静脉入路[25]，且 Choi 等进一步证实了股静脉入路回收时间显著短于颈静脉入路，这可能与不同入路造成的倾角不同的缘故[41]。

最近，King 等随访了 5780 个病例，通过分析证实了颈静脉入路是滤器血栓形成的独立危险因素(HR: 2.2, P = 0.001)。而经颈静脉入路释放通常适用于下腔静脉血栓或双侧下肢静脉血栓的患者，这类患者因血栓阻塞使得下腔静脉血流速度和量受限更易导致血栓形成[43]。不同入路对滤器倾斜角度影响大，也可能与滤器血栓形成有关，但还需未来研究来进一步探索机制。

3.3. 下腔静脉

下腔静脉滤器置入前，需进行下腔静脉造影评估腔静脉直径、形态、肾静脉开口位置及是否存在腔静脉血栓等[1] [44]。Laidlaw 等分析了 252 例患者，发现腔静脉直径与滤器置入后倾斜角度变化值存在正相关关系，如放置位置 IVC 直径每增加 1 cm，倾斜变化增加 4.0°，该研究也证实了倾角变化值与

滤器先进取出技术的使用密切相关(*OR*: 1.09, *P* = 0.01) [46]，尽管并未证实腔静脉直径与辅助回收技术的使用的直接相关性[31] [45] [46]。这可能与滤器支撑力有关，腔静脉直径越大，滤器滤腿对腔静脉壁的径向支撑力小，难以保持在非均匀血流中的稳定性。故而滤器放置时，注意不同滤器的置入对腔静脉直径上限要求。

除了考虑腔静脉直径，置入滤器时还要考虑预放置位置腔静脉的扭曲程度、形态及周围组织的压迫，尽管目前认为倾斜角度 15° 为临界值，但当腔静脉足够大时，滤钩可能也未贴壁，对回收也不会造成太大困难。而 Lee 等认为倾角大于 9.25°即有可能出现滤钩贴壁(*OR*: 4.56)，因为腔静脉壁外组织可能将腔静脉壁压向滤钩造成贴壁[47]。Ming 等认为滤器放置后若局部腔静脉扩张大于相邻正常腔静脉 50%，显著增加了滤器血栓形成的风险[30]。

腔静脉直径还可能与滤器穿透有关。有研究发现显著的穿透与腔静脉直径小于 24.2 mm 有关，腔静脉直径越小，越有可能穿透，这可能与滤器支撑力及滤腿与狭窄腔静脉的接触面积增大有关[47] [48]。然而，滤器移位却是相反，腔静脉直径越小，滤器产生的支撑力可与腔静脉贴合，使得滤器更不容易移位，反之，则容易产生移位[49]。

腔静脉直径若大于 28 mm，滤器的拦截效率受到影响，滤器置入后易发生栓塞、肺栓等[49]，既往体外研究认为，滤器捕获血栓的能力遂直径增加而减小[50]。然而这在临床还未得到充分证实，但滤器置入后再发肺栓的发生率大概在 0.5%~6% [51]。故而放置前造影评估预放置位置腔静脉直径及形态，将滤器部署在合适位置，可减小并发症、减小回收难度，提高回收率。

3.4. 距离肾静脉的距离

尽管不同滤器对放置位置与肾静脉的距离并未形成统一意见，但根据指南推荐，滤器通常放置位置为平对最低肾静脉开口或低于最低肾静脉开口[5]。当常规释放位置存在血栓等因素时，放置位置通常会往上调整。有研究也表明肾上型滤器的并发症及回收难度并未显著增加，同时肾功能也未受影响[52]。同样 Lee 等随访病例观察到滤器平对肾静脉开口释放，回收时未见血栓形成[48]。除此之外，Grubman 等回顾分析了 1497 名患者，发现腔静脉滤器距离肾静脉的不同位置放置，肺栓塞、滤器穿透、移位、血栓形成发生率相似且均较低[53]。同样，Tullius 等回顾性分析了肾下滤器滤钩到最下肾静脉开口下不同距离分组(<1 cm, 1~2 cm, >2 cm)与留置并发症的关系，分析得出各组支柱穿透力、邻近内脏穿透力、滤器移位、倾斜均无显著差异[54]。然而有研究表明首次回收时的 Günther Tulip 滤器倾斜幅度与肾静脉汇合点下方 40 mm 的下腔静脉直径呈正相关，因为这个位置为 Günther Tulip 滤器滤腿末端锚定点附近[45]。这个位置的直径越大，倾角越大，这也证实了前面腔静脉直径与倾角的关系。故而我们可以认为常规放置位置距离肾静脉开口的远近与滤器血栓、移位等并发症并无显著相关，应更多考虑放置位置倾斜直径、形态等。

3.5. 滤器放置倾斜角度

滤器放置倾斜几乎存在所有可回收滤器中，影响因素可能包括入路、腔静脉直径、品牌等。但对于放置倾斜的影响，不少研究表明，放置倾斜似乎和回收困难无显著直接相关性。但 Kostiuk 等分析了困难组与非困难组放置倾斜角度，发现困难组放置倾斜角度显著高于非困难组[55]。放置倾斜角度与回收的关系尚未明确，但如前文所述，其与回收时倾角大小呈正相关[9] [40]。有研究表明滤器倾斜在造成滤器回收困难的因素中占比最高位 43% [23]。故而可认为，减小放置倾角也许可减小回收时倾角大小，也许对增加滤器回收率有积极作用。有研究认为过大的倾斜(>15°)可能会影响滤网拦截血栓的能力以及增加血栓形成风险、滤器穿透风险，这时可能需要更多操作程序进行矫正[30] [56]，当然未来还需大样本、多品牌、

多中心研究来论证。

3.6. 滤钩开口方向及钩－倾的关系

滤器放置时，滤钩的朝向和滤钩倾斜的方向的关系也许会给回收造成一定影响，理论上如果滤钩开口朝向和倾斜方向一致那么很有可能造成滤钩贴壁，甚至造成滤钩内嵌，对滤器回收造成困难，毕竟两者是目前常造成困难的重要因素。然而，一项研究表明，滤钩的开口朝向以及其与倾斜的关系似乎并不造成困难回收。这也就是说滤器放置时，滤钩开口方向及其与钩端倾斜的关系并不影响滤器的回收[9]。当然，当滤钩倾斜且钩－倾方向相同时，滤钩开口与腔静脉的距离越近，圈套器越难套取，极端的情况就是滤钩贴壁，但是要考虑倾斜角度大小，故而我们推测滤钩开口与钩端倾斜方向的关系可能会影响回收时透视的时间。

4. 小结

可回收下腔静脉滤器放置因素可影响着延期并发症的发生，这些并发症可能给患者带来新的症状或经济负担，可能给滤器回收带来困难，影响回收率，故而在滤器放置时应当更多关注滤器品牌、腔静脉形态及直径、静脉入路、放置倾斜角度等因素，可提高滤器回收率，减小并发症率，这对医生和患者均有益处。

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