

# 单侧枢椎椎板螺钉在椎动脉变异的上颈椎不稳中的临床应用

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**【摘要】 目的:**探讨后路寰椎侧块螺钉联合单侧枢椎椎板螺钉+对侧枢椎椎弓根螺钉固定、自体双皮质骨加压植骨融合术治疗上颈椎不稳伴椎动脉变异的临床疗效。**方法:**2008年6月至2012年12月,行后路寰椎侧块螺钉联合单侧枢椎椎板螺钉+对侧枢椎椎弓根螺钉固定、自体双皮质骨加压植骨融合术12例,男8例,女4例,年龄16~77岁,平均47.5岁。术前患者枕颈部活动受限或不伴疼痛,VAS评分0~7分,平均 $3.50\pm 2.71$ ;椎动脉造影或颈椎CTA示单侧椎动脉明显狭窄。观察术中是否有神经及血管损伤;术后7d内行X线和CT检查,了解内固定位置;术后随访观察有无内固定松动、断裂失败并发症、复位丢失,以及植骨融合率等。**结果:**12例单侧枢椎椎板螺钉固定,术中未发生神经和椎动脉损伤。患者颈部VAS评分 $0.92\pm 0.90$ ,较术前明显减轻( $P=0.01$ )。术后X线示12例患者颈椎序列恢复良好,CT示1例枢椎椎板腹侧皮质侵犯,余位置均良好。12例患者均获得随访,时间6个月~3年;未见内固定松动、断裂和复位丢失等并发症;术后6个月12例均骨性融合。**结论:**后路寰椎侧块螺钉联合单侧枢椎椎板螺钉+对侧枢椎椎弓根螺钉固定、自体双皮质骨加压植骨融合术,既避免了传统螺钉固定椎动脉损伤的同时,又克服了部分病例双侧枢椎椎板螺钉时植骨床的不足,在保证良好力学稳定的情况下,可以取得良好的骨性融合率。单侧枢椎椎板螺钉可以作为一种安全有效的补充固定措施应用于椎动脉变异的上颈椎不稳患者中。

**【关键词】** 单侧椎板螺钉; 内固定; 上颈椎不稳; 椎动脉变异

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**Clinical application of unilateral axis translaminar screws in upper cervical instability with vertebral artery variations** CHEN Bi, TENG Hong-lin, DAI Yu-sen, WANG Jing, ZHU Min-yu, and LI Chi. Department of Orthopaedics, the First Affiliated Hospital of Wenzhou Medical University, Wenzhou 325000, Zhejiang, China

**ABSTRACT Objective:** To investigate the clinical outcomes of the posterior C<sub>1,2</sub> screw-rod combined with C<sub>2</sub> unilateral translaminar screw and contralateral pedicle screw fixation and autogenous bicortical iliac crest graft fusion in treating upper cervical instability with vertebral artery variations. **Methods:** From June 2008 to December 2012, the clinical data of 12 patients with upper cervical instability underwent C<sub>1</sub> lateral mass screws-C<sub>2</sub> unilateral laminar and contralateral pedicle screws fixation combined with autogenous bicortical iliac crest graft fusion were analyzed retrospectively. There were 8 males and 4 females with a mean age of 47.5 years (ranged, 16 to 77 years). Patients suffered from occipitocervical activity limitation of motion with pain or not, VAS was 0-7 points with an average of ( $3.50\pm 2.71$ ) points. Unilateral vertebral artery hypoplasia was demonstrated by vertebral arteriography (VAG) or CTA in all patients. Cervical X-ray and CT scans were done within 7 days after surgery in order to confirm internal fixation position. Internal fixation loosening and breakage, reduction losing, bone fusion ratio were observed during follow-up. **Results:** No nerves and vertebral artery injuries occurred during operation. Cervical pain obviously decreased and VAS was ( $0.92\pm 0.90$ ) points. Cervical alignment of 12 patients had well-recovered by X-ray while Atlantoaxial ventral lamina cortex of 1 case was encroached by CT scan without neurological symptom. All patients were followed up for 6 months to 3 years, no internal fixation loosening and breakage, reduction losing were found. All patients obtained bone fusion in 6-12 months after operation. **Conclusion:** Posterior C<sub>1</sub> lateral mass screws-C<sub>2</sub> unilateral laminar and contralateral pedicle screws fixation combined with autogenous bicortical iliac crest graft fusion can achieve biomechanical stability and raise the successful rate of bone fusion, while avoiding the risk of vertebral artery injury and overcoming the insufficient of bone fusion during bilateral laminar screws placement as well. Posterior C<sub>1</sub> lateral mass screws fixation is a safe and effective additional method in treating upper cervical instability with vertebral artery variations.

**KEYWORDS** Unilateral laminar screw; Internal fixation; Upper cervical instability; Vertebral artery variation

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后路螺钉固定,如 Magerl 经关节螺钉技术(transarticular screw, TA), C<sub>1</sub> 侧块联合 C<sub>2</sub> 椎弓根螺钉(C<sub>1</sub> lateral mass screws - C<sub>2</sub> pedicle screws, C<sub>1</sub>LM-C<sub>2</sub>PD)技术<sup>[1]</sup>,凭借着其优异的力学稳定性和术后融合率,基本取代了传统 Brooks 和 Gallie 线缆技术,在治疗上颈椎不稳病例得到了充分应用,并取得了良好的临床疗效。但大量关于椎动脉损伤(iatrogenic vertebral artery injury)的临床报道引起了学者的广泛重视<sup>[2-3]</sup>。为了降低椎动脉损伤的发生率,2004 年, Wright<sup>[4]</sup>首先报道了枢椎椎板螺钉(C<sub>2</sub> translaminar screws, C<sub>2</sub>TL)技术,并取得了良好的临床疗效,未见内固定失败或者椎动脉损伤发生。自 2008 至 6 月至 2012 年 12 月,笔者对常规双侧枢椎椎板螺钉进行改良,采用后路寰椎侧块螺钉联合单侧枢椎椎板螺钉+对侧枢椎椎弓根螺钉固定、自体双皮质骨加压植骨融合术治疗上颈椎不稳 12 例,临床结果总结分析如下。

## 1 临床资料

本组 12 例,男 8 例,女 4 例;年龄 16~77 岁,平均 47.50 岁。齿状突骨折 II 型和 III 型共 4 例;寰枢椎脱位合并高位脊髓压迫症 6 例;寰枢椎不稳伴寰椎发育畸形 1 例;寰椎骨折伴脊髓损伤 1 例。患者表现为枕颈部活动受限或不伴疼痛,VAS 评分 0~7 分,平均 3.50±2.71,入院后常规予以颅骨牵引。椎动脉造影或颈椎 CTA 示患者单侧椎动脉明显狭窄。所有病例术前常规摄颈椎正侧位及动力位片观察寰枢椎解剖关系及稳定性;颈椎 MRI 检查明确脊髓等神经结构受压损伤情况;颈椎 CT+二维、三维重建排除骨性结构异常,并对枢椎横突孔位置、椎弓根大小、椎板厚度常规进行评价和测量。

## 2 治疗方法

本组患者寰椎行侧块螺钉固定,椎动脉狭窄侧枢椎行椎板螺钉置钉,对侧行枢椎椎弓根螺钉置钉。

**2.1 体位及暴露** 气管插管全麻后,患者取俯卧位,并保持头部中立位于头架上。常规颅骨牵引维持头颈部的稳定。枕颈部后正中切口,先后暴露枢椎、寰椎后弓。

**2.2 螺钉的安置** ①寰椎侧块螺钉固定:暴露寰椎后弓下方,用神经剥离子探及侧块下壁、内侧壁和中央部分,磨钻开口后,旋入直径 3.5~4.0 mm,长度 2.4~3.0 cm 多轴螺钉 2 枚;②枢椎椎弓根螺钉固定:沿 C<sub>2</sub> 一侧椎板上缘及椎弓根内侧缘,探及 C<sub>2</sub> 椎弓根的上壁及内侧壁,磨钻开口定位后,电钻进入约 2.2 cm 长,用球型探针探查钉道无异常后,旋入直径 3.5~4.0 mm,长度 2.2~3.2 cm 椎弓根螺钉 1 枚;③单侧枢椎椎板螺钉固定:入钉点位于枢椎椎板与棘突

的交接处上下缘中点附近,用高速磨钻在入钉点磨去少许皮质骨开口后,用手钻向枢椎对侧椎板钻孔。螺钉方向在直视下与椎板平面平行,可略向枢椎椎板背侧倾斜,减少腹侧椎板皮质损伤的可能。用球型探针探查钉道,了解是否触及或穿透椎板腹、背侧皮质,测深、攻丝,再用探针探查,最后旋入直径 3.5~4.0 mm,长度 2.0~2.8 cm 椎板螺钉 1 枚。

**2.3 寰枢椎间双面皮质骨加压植骨技术** 螺钉成功植入后,用高速磨钻常规处理寰椎后弓表面及其下缘、枢椎椎板和棘突表面及其上缘,磨去相应结构表面的皮质骨。选择合适尺寸的钛棒,安装连接。通过钛棒的塑形来复位寰枢椎,恢复上颈椎序列。测量寰椎后弓与枢椎椎板之间的距离,然后从患者髂骨取一略大于此高度的三面皮质骨,并将其处理成双面皮质骨填塞于寰椎后弓与枢椎椎板棘突之间。两侧螺钉纵向加压,夹紧植骨块进行融合,最后取剩余的碎骨粒(必要时加用异体骨)加强后方植骨。

**2.4 术后处理** 闭合切口,负压引流 24~48 h。术后即刻去除颅骨牵引,术后 2~3 d 即可坐起,并逐渐增加活动。术后颈托外固定 8~12 周。

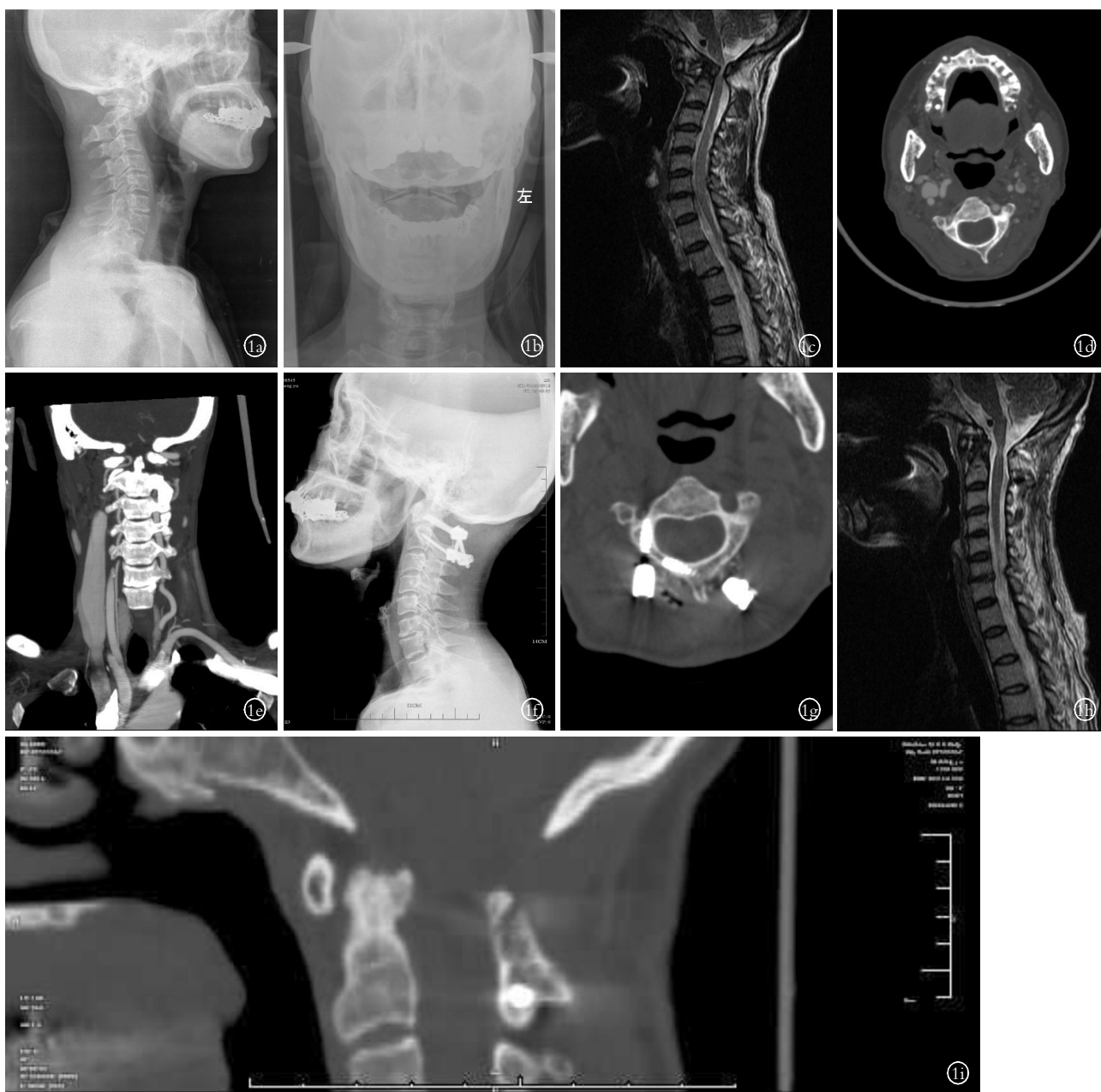
## 3 结果

**3.1 疗效评定** 术后重新评估枕颈部疼痛 VAS 评分;7 d 内摄 X 线正侧位片和行 CT 检查,了解内固定位置;采用门诊随访,要求术后 1、3、6 个月随访拍片及 CT 检查,以后每半年随访,观察有无内固定松动、断裂失败并发症、复位丢失;融合评估主要采用术后 CT 二维重建,观察植骨块与 C<sub>1,2</sub> 接触界面是否有骨小梁通过<sup>[5]</sup>。采用 SPSS 21.0 软件进行统计分析。手术前后 VAS 评分采用配对 *t* 检验,以 *P*<0.05 为差异有统计学意义。

**3.2 治疗结果** 12 例患者均行枢椎单侧椎板螺钉固定,所有寰枢椎螺钉均一次性成功植入。术中无脊髓和椎动脉损伤发生。术后 VAS 评分 0.92±0.90,较术前明显减轻(*P*=0.01)。12 例患者术后 7 d 内 X 线显示颈椎序列恢复良好,CT 显示 1 例患者枢椎椎板腹侧皮质受累,椎管未侵犯,患者无神经功能受损表现,余螺钉位置正常;12 例患者均获得随访,时间 6~36 个月;未见内固定松动、断裂和复位丢失等并发症;术后 6 个月 X 线片或 CT 检查均见骨性融合。典型病例见图 1。

## 4 讨论

**4.1 枢椎椎板螺钉的必要性** 近 20 多年来,上颈椎后路螺钉内固定技术,如 Magerl C<sub>1,2</sub> 经关节螺钉固定技术(TA)、后路 C<sub>1</sub> 侧块联合 C<sub>2</sub> 椎弓根螺钉(C<sub>1</sub>LM-C<sub>2</sub>PD)Harms<sup>[1]</sup>技术,凭借着其优异的力学稳定性和术后融合率,基本取代了传统后路线缆技术,



**图 1** 女性患者, 57 岁, 寰枢椎关节脱位, 高位脊髓压迫症, 类风湿性关节炎 **1a.** 术前侧位片见寰枢椎脱位 **1b.** 术前张口位片未见明显异常 **1c.** MRI 示寰枢椎脱位, 脊髓压迫 **1d.** 术前 CT 示左侧枢椎椎弓根狭窄 **1e.** 术前 CTA 示左侧椎动脉优势侧 **1f.** 术后侧位片示螺钉位置良好 **1g.** 术后 CT 示寰椎侧块螺钉、枢椎左侧椎板螺钉、枢椎右侧椎弓根螺钉位置良好 **1h.** 术后 MRI 示脊髓压迫解除 **1i.** 术后 6 个月 CT 重建示植骨块骨性融合。

**Fig.1** A 57-year-old female patient with atlantoaxial dislocation, high spinal cord compression, rheumatoid arthritis **1a.** Preoperative lateral X-ray showed atlantoaxial dislocation **1b.** Preoperative C-spine open mouth X-ray did not show obviously abnormal **1c.** Preoperative MRI showed atlantoaxial dislocation and spinal cord compression **1d.** Preoperative CT showed the left axis pedicle was stenosed **1e.** Preoperative CTA showed that left vertebral artery dominance **1f.** Postoperative lateral X-ray showed that the place of screw was good **1g.** Postoperative CT showed that the mass lateralis atlantis screw, atlantoaxial left and right laminar screws was in good position **1h.** Postoperative MRI showed that the decompression of spinal cord was removed **1i.** CT scan at 6 months after operation showed the bone fusion

在治疗上颈椎不稳病例得到了充分应用。但大量有关医源性椎动脉损伤 (VAI) 的临床报道<sup>[2-3,6]</sup>引起了学者们的广泛重视。Yeom 等<sup>[7]</sup>研究表明 C<sub>2</sub> 椎动脉“高跨 (high-riding)”的发生率将近 14.5%, 并进一步对椎动脉高跨畸形患者行影像学评估, 指出 Harms

技术和 TA 技术的 C<sub>2</sub> 横突孔侵犯的风险分别为 49% 和 63% (P=0.02)。此外, 正常人群中两侧椎动脉通常是不对称的, 超过 50% 的人群存在椎动脉优势侧 (vertebral artery dominance, VAD), 少部分人出现单侧椎动脉发育不良 (hypoplastic), 甚至未发育 (atret-

ic)。此时,常规螺钉置钉时若发生椎动脉优势侧或者发育侧损伤,结果必然是灾难性的。2004 年, Wright<sup>[4]</sup>提出并报道了枢椎椎板螺钉技术,并取得了良好的临床疗效,未见内固定失败或者椎动脉损伤发生,此后双侧交叉 C<sub>2</sub> 椎板螺钉一直被视为可以降低椎动脉损伤的风险。

**4.2 单侧枢椎椎板螺钉的解剖意义** 马向阳等<sup>[8]</sup>通过对亚裔人尸体枢椎解剖研究发现 83.3%标本两侧椎板厚度≥4.0 mm,棘突高度≥9.0 mm,这一比例要更低于 Cassinelli 等<sup>[9]</sup>的研究结果,胡勇等<sup>[10]</sup>也验证了国人枢椎椎板螺钉置钉的可行性。但是,少部分人群的枢椎椎板单侧或双侧无法容纳常规直径 4 mm 的枢椎椎板螺钉;即使双侧椎板厚度及棘突高度能够满足双侧椎板螺钉置钉,部分枢椎椎板上缘去皮质后往往没有足够的植骨床以进行寰枢椎之间的植骨,而这点可能是一部分病例术后骨不愈或假关节形成的主要原因。因为双侧枢椎椎板螺钉置钉时,尤其在棘突及椎板高度较低的病例,枢椎椎板或棘突去皮质时可能会显露螺钉而影响内固定的稳定性。此外,双侧置钉时钉帽亦会增加结构性植骨的困难,进一步影响植骨的效果。采用单侧椎板中央螺钉置钉联合对侧椎弓根螺钉置钉的方法,可以很好地解决上述问题。

**4.3 单侧枢椎椎板螺钉的可行性** 日本学者 Matsubara 等<sup>[11]</sup>报道了 1 例单侧椎动脉闭锁的风湿性寰枢关节脱位的患者,对椎动脉闭锁侧行枢椎椎弓根螺钉固定,优势侧(对侧)行椎板螺钉固定,联合寰椎侧块螺钉行寰枢融合术,并取到成功。另外, Gorek 等<sup>[12]</sup>对 3 种寰枢椎螺钉内固定术(枢椎双侧椎弓根螺钉、单侧椎板螺钉+对侧椎弓根螺钉和双侧椎板螺钉)进行生物力学研究,结果发现 3 种固定方式的力学稳定性无显著差异。可见,单侧枢椎椎板螺钉联合对侧椎弓根螺钉在保证寰枢椎内固定稳定性的前提下,既显著降低了单侧椎动脉优势侧患者椎动脉损伤的可能性,又克服了部分患者椎板无法行双侧螺钉置钉的解剖限制。

**4.4 枢椎椎板螺钉的局限性** 继 Wright 报道的后续临床研究<sup>[13-17]</sup>示枢椎椎板螺钉联合传统 Harms 等螺钉内固定技术可取得 90%以上的术后融合率,但是假关节形成、骨不愈、枢椎椎板螺钉拔出、椎板内外侧皮质侵犯等并发症时有发生, Meyer 等<sup>[17]</sup>甚至报道 1 例椎管内侵犯>4 mm 而不得不行翻修手术,幸运的是患者没有出现神经症状。此外, Riesenburger 最新研究结果显示采用双侧交叉 C<sub>2</sub> 椎板螺钉行寰枢椎融合术同样存在横突孔或 C<sub>1,2</sub> 椎间隙的椎动脉损伤的风险,并指出为了避免椎动脉的损伤,

尽量选用长度在 28 mm 以下 C<sub>2</sub> 经椎板螺钉。相关生物力学研究表明,在屈/伸动作中,椎板螺钉固定可以获得与 TA 和 C<sub>1</sub>LM-C<sub>2</sub>PD 相近的力学稳定<sup>[12,18]</sup>。但是椎板螺钉在维持侧屈/旋转稳定性方面,相较传统固定方式稳定性有所下降<sup>[19]</sup>,并且 Lehman 等<sup>[20]</sup>生物力学研究发现,枢椎椎板螺钉的抗拔出能力要显著低于椎弓根螺钉。鉴于此,笔者认为, Harms 枢椎椎弓根螺钉内固定术仍然是上颈椎内固定中的标准术式,在椎动脉变异的患者中,枢椎椎板螺钉技术尤其是单侧技术可以作为一种补充术式来避免术中椎动脉优势侧或发育侧损失造成的严重并发症。

**4.5 自体双皮质髂骨块加压植骨的应用** 不少学者<sup>[21-22]</sup>在行上颈椎后路螺钉内固定时,往往增加线缆环扎技术以期寰枢之间更高<sup>[23]</sup>的骨性融合率。然而, Lapsiwala 等<sup>[18]</sup>生物力学研究显示后路线缆环扎技术没有显著增加 Harms 螺钉固定技术的稳定性;此外线缆环扎技术操作繁琐,一旦出现脊髓损伤后果将不堪设想。2012 年,倪斌等<sup>[24]</sup>报道了一种改良型 Harms 寰枢椎钉棒固定系统联合自体双皮质髂骨块加压植骨,术后 3 个月 94.3%(33/35)的患者取得了骨性愈合。本组患者在寰枢椎钉棒内固定的同时均采用自体双皮质髂骨块加压植骨,术后疼痛较前明显缓解,患者随访取得了良好的融合率。利用钉棒系统对植骨块加压植骨,不仅可避免线缆技术固有的脊髓损伤的严重并发症,而且加压技术巧妙地利用了 Woff 定律促进植骨的融合。

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文稿的一稿两投、一稿两用、抄袭、假署名、弄虚作假等现象属于科技领域的不正之风, 我刊历来对此加以谴责和制止。为防止类似现象的发生, 我刊一直严把投稿时的审核关, 要求每篇文章必须经作者单位主管学术的机构审核, 附单位推荐信(并注明资料属实、无一稿两投等事项)。希望引起广大作者的重视。为维护我刊的声誉和广大读者的利益, 凡核实属于一稿两投和一稿两用等现象者, 我刊将择期在杂志上提出批评, 刊出其作者姓名和单位, 并对该文的第一作者所撰写的一切文稿 2 年内拒绝在本刊发表, 同时通知相关杂志。欢迎广大读者监督。

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