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Gekko Coil System for Intracranial Aneurysms Treatment in China (GREAT-China): A Prospective Randomized Controlled Open-Label Noninferiority Trial

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■ OBJECTIVE: **This study aimed to evaluate the safety and efficacy of the Gekko coil system in treating intracranial aneurysms (IAs) in clinical practice.**

■ METHODS: **A prospective multicenter randomized open-label parallel positive control noninferiority trial was conducted by 11 centers in China. Patients with a target IA were randomized 1:1 to coiling with either Gekko or Axium coils. The primary outcome was successful aneurysm occlusion at 6 months postoperative follow-up, whereas the secondary outcomes included the successful occlusion aneurysm rate in the immediate postoperative period, recanalization rate at the 6 months follow-up, and technical success and security.**

■ RESULTS: **Between May 2018 and September 2020, 256 patients were enrolled and randomized. Per-protocol analysis showed that the successful aneurysm occlusion rate at 6 months was 96.08% for the Gekko coil group compared with 96.12% in the Axium coil group, with a difference of −0.04% ($P = 0.877$). The successful immediate aneurysm occlusion rates were 86.00% and 77.45% in the Gekko coil group and the Axium coil group, respectively, showing no significant difference between the 2 groups ($P = 0.116$), whereas the recanalization rates during the 6 months follow-up were 2.02% and 1.96% in the Gekko and Axium coil groups, respectively, which was not statistically significant ($P = 1.000$).**

■ CONCLUSIONS: **This trial showed that the Gekko coil system was noninferior to the Axium coil system in terms of efficacy and safety for IA embolization. In clinical practice, the Gekko coil system can be considered safe and effective for treating patients with IA.**

INTRODUCTION

Endovascular embolization has emerged as the preferred first-line treatment for intracranial aneurysms (IAs), given its significantly lower mortality and disability rates

Key words
- Coil
- Complication
- Device
- Intracranial aneurysm

Abbreviations and Acronyms
CEC: Clinical Event Committee
FAS: Full analysis set
IA: Intracranial aneurysms
mRS: Modified Rankin Scale
PPS: Per-protocol set
SAE: Serious adverse event
SS: Safety set

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compared with craniotomy clipping.[1-3] Although various types of coils, such as hydrogel-coated and biodegradable polyglycolic/polylactic acid—coated coils, have been developed to enhance aneurysm occlusion and angiographic outcomes,[4-6] coil embolization incorporating bare-metal coils remains a critical component in IA treatment.

The softness of coils is an essential indicator.[7] Softer coils offer a higher packing density, reducing the risk of intraprocedural rupture by exerting lower pressure on the aneurysm wall. The Gekko coil system (Tonbridge, Zhuhai, Guangdong, China) is a novel mechanical detachable bare-metal coil, designed with a smaller coefficient (k) and primary wire diameter to improve softness and packing density (**Supplementary Figure 1**).

Consequently, a multicenter randomized controlled trial was conducted in China to comprehensively evaluate the safety and effectiveness of the Gekko coil in the treatment of IA by comparing the efficacy of the Axium Coil (Medtronic, Minneapolis, Minnesota, USA), serving as a positive control. This trial filled a crucial knowledge gap and contributed to the understanding of the clinical outcomes and benefits associated with the Gekko coil system in IA treatment.

METHODS

Study Design and Patients

The ethics committee of each participating center approved the protocol, and written informed consent was obtained from all patients. The design and implementation of the clinical trial followed the ethical guidelines of the Declaration of Helsinki and complied with the relevant provisions of China's current regulations.

A prospective multicenter randomized open-label parallel positive control, noninferiority trial was conducted at 11 research centers in China. Eligible patients, aged 18—80 years, who were diagnosed with a single untreated intracranial saccular aneurysm (modified Rankin Scale [mRS] score, 0—2; Hunt and Hess scale score, I—III) between May 28, 2018 and September 2, 2020, were included. Patients who had previously received other endovascular interventional therapies for the target aneurysm were excluded. The detailed inclusion and exclusion criteria are listed in the study protocol, provided in the **Appendix**.

Patients were randomly allocated to the test (Gekko coil) and control (Axium coil) groups. The trial was conducted as an open design, meaning that both researchers and patients were not blinded to the treatment. However, the core laboratory researchers who evaluated the primary indicators were blinded. The collected data were analyzed and compared to evaluate the effectiveness and safety of the Gekko coil system for the treatment of IA.

Randomization and Masking

Randomization in this trial was conducted using a dynamic randomization process facilitated by the interactive Web response system. Random numbers and device assignments were generated by the data acquisition station to ensure unbiased allocation. The minimization algorithm was used to control the balance of 4 influencing factors: the neck, diameter, location, and state of rupture of the aneurysm.

An independent core laboratory was responsible for the assessment of primary and secondary efficacy end points. The independent laboratory comprised 3 members either qualified in neuroimaging or with equivalent qualifications by assessing and correlating angiograms according to the 3-point Raymond scale. The masked collated digital copies of angiogram images were used, to ensure blinding. However, the investigator's judgment about the patient's imaging results was used to guide the patient's clinical treatment and selection of the follow-up treatment.

To ensure an objective assessment of adverse events, an independent Clinical Event Committee (CEC) comprising 3 clinical experts was established. The CEC was responsible for reviewing and adjudicating all deaths and serious adverse events (SAEs) encountered during the trial. SAEs were defined as any adverse event resulting in death or severe deterioration in a patient's health, including life-threatening illness or injury, permanent impairment of a body structure or function, and hospitalization or prolongation of existing hospitalization. Under blinded conditions, the CEC members evaluated the cause of each SAE and its relationship with the test device according to the patient image and medical record information.

Procedures

All procedures were performed under general anesthesia using a transfemoral method that maintained the heparin dose at 100 units/kg to sustain an activated clotting time of 250—350 seconds in the course of the method after sheath placement, accompanied by placement of an appropriate guiding catheter in the internal carotid or vertebral artery. Subsequently, coils were delivered into the target aneurysm through the microcatheter and other auxiliary devices and detached after satisfactory placement. In addition, it is recommended that the total test or control coil length used in every aneurysm must be more than 50% of the total length of the coils, whereas balloon-assisted and/or stent-assisted coiling should be used for wide-neck aneurysms; therefore, all fundamental stents besides the flow diverter and protected stent should be used. Subsequently, all relevant data were recorded, including the location and size of the aneurysm, aneurysm neck width and shape, diameter of the parent artery, and treatment outcomes.

Outcome Measurements

The primary outcome measure was the successful occlusion rate at 6 months postoperative follow-up. All procedures were performed under general anesthesia using a transfemoral approach. Successful occlusion was defined as an aneurysm with Raymond class I or II occlusion using test or control devices. The secondary outcome measures included the successful occlusion and recanalization rate in the immediate postoperative period and at 6 months postoperative follow-up, respectively. The recanalization rate was defined as the percentage of patients with a decreased degree of aneurysm occlusion during the follow-up period compared with immediately postoperative.

In addition, safety outcome measurements included postoperative aneurysm bleeding rate, mRS score, retreatment rate, incidence of adverse events, and SAEs throughout the trial. Device performance was evaluated by the implantation success rate, operation satisfaction rate, and incidence of device defects. The standard of successful implantation referred to the coil being

placed in an ideal position, the coil being smoothly detachable, and the rest being withdrawn to the outer body. The operation of the medical test device or the control device with a Likert score ≥16 was considered satisfactory.[8]

Statistical Analyses

According to a comprehensive literature review and clinical experience, taking the primary end point (successful occlusion rate 6 months after the procedure) as the basis for sample size estimation, it was assumed that the successful aneurysm occlusion rate in the control group was approximately 90% at 6 months postoperative follow-up. The test group was expected to achieve the same adequate level and the noninferiority boundary was set at 12.0%. As a 1-sided test, the significance level was $\alpha = 0.025$ and power $(1-\beta) = 80\%$. According to the sample size estimation formula,[9] the sample size of this trial was at least 96 cases in each group, making a total of 192 cases. Considering the number of patients who may drop out during the trial to be approximately 25%, the sample size was expanded to 256 patients (i.e., 128 patients were selected in each group).

The full analysis set (FAS) was the set of patients recruited, treated, and determined using baseline assessment data according to the intention-to-treat principle. Contrastingly, patients with missing occlusion degree results of the aneurysms at 6 months postoperatively were considered to have unsuccessful occlusion. The per-protocol set (PPS) was the subset of FAS (including patients who had received the treatment prescribed in the protocol) that had no missing primary outcome observation data and excluded severe violations of the protocol. The safety set (SS) referred to the group of patients who received treatment after randomization and had ≥1 safety evaluations. Effectiveness analysis was performed in both FAS and PPS subgroups. All baseline demographic data were analyzed in the FAS subgroups, and safety evaluation was based on SS.

Most statistical tests were 2-sided (except for special instructions) and statistical significance was set at $P < 0.05$. The independent t test and Wilcoxon rank sum test were used for the comparison between groups of quantitative data according to the data distribution. The χ^2 test was used for classified data, and the Cochran-Mantel-Haenszel test was used for grade data. Assuming that the results of the latest observations were the same as the missing part of the trial data, we conducted an intention-to-treat analysis as a further sensitivity analysis.

The medical statistics office performed the statistical analyses process. SAS version 9.4 (SAS Institute Inc., Cary, North Carolina, USA) was used for statistical analysis and was run at a 5% type I error rate. The independent data and safety monitoring committee had unrestricted data access and monitored the progress of the trial.

RESULTS

Patient Demographics and Characteristics

A total of 256 patients were randomized and underwent procedures (test group, 129; control group, 127). The FAS and SS subgroups were formed according to the intention-to-treat principle. Among the 256 treated patients, 205 were included in the PPS (102 in the test group and 103 in the control group). The baseline characteristics between the 2 groups in the FAS showed a similar distribution. Of the 256 treated patients, 232 patients completed the 6-month postoperative follow-up, including 118 and 114 patients in the test and control group, and 227 patients completed the 12-month follow-up, including 113 and 114 patients in the test and control group, respectively. The dropout rates for the 6- and 12-month follow-ups were 9.38% and 14.06%, respectively. The flow diagram details are presented in **Figure 1** and **Table 1**.

Primary Outcome

Primary outcome data based on core laboratory data sets were available for 205 patients (PPS). The successful occlusion rate at 6 months postoperative follow-up was 96.08% (98/102) in the test group and 96.12% (99/103) in the control group, resulting in a difference of −0.04% (95% confidence interval [CI], −5.34% to 5.26%; $P = 0.877$). The lower 95% CI boundary (5.34%) exceeded the noninferiority boundary (−12%), which matched the noninferiority criteria. Details are presented in **Figure 2** and **Table 2**.

Secondary Outcome

The immediate postoperative successful occlusion rate was 86.00% (86/100) compared with 77.45% (79/102) in the test and control group based on the statistical analysis of PPS. There was no significant difference between the 2 groups ($P = 0.116$). Details are presented in **Table 2**. The recanalization rates at 6 months follow-up in the test and control groups were 2.02% (2/99) and 1.96% (2/102), respectively, with no statistical difference observed ($P = 1.000$). Details are presented in **Table 2**.

Safety Evaluation Indicators and Adverse Events

No target aneurysmal bleeding occurred in either group during the 12-month postoperative follow-up period. In the test group, 84.75% (100/118) of patients presented with an mRS score of 0 at 6 months postoperative follow-up, whereas 88.60% (101/114) of patients in the control group had an mRS score of 0, with no significant difference ($P = 0.259$). At 12 months follow-up, 89.38% (101/113) of the test group and 91.23% (104/114) of the control group had an mRS score of 0, showing no significant difference between the 2 groups ($P = 0.516$).

Two patients in the control group accepted retreatment (2/127; 1.57%), whereas 3 patients in the test group received retreatment (3/129; 2.33%). Thus, no significant difference was observed between the 2 groups ($P = 1.000$). In the test group, 3 patients died, resulting in a mortality of 2.33% (3/129), and 2 patients died in the control group, resulting in a mortality of 1.57% (2/127). There was no significant difference between the 2 groups ($P = 1.000$).

During the 12-month follow-up period, 62 patients in the test group had 163 adverse events, resulting in a 48.06% (62/129) incidence of adverse events. In the control group, 66 patients had 170 adverse events and, thus. the incidence of adverse events was 51.97% (66/127). The difference between the 2 groups was not significant ($P = 0.617$). The incidence of SAEs during the 12-month follow-up period was 12.40% (16/129) and 16.54% (21/127) in the test and control groups, respectively, thereby suggesting that no statistically significant difference was noted between the 2 groups ($P = 0.378$). Details are presented in **Tables 3** and **4**.

Device Performance Evaluation

Per-protocol analysis showed that the implantation success rate, operation satisfaction rate, and incidence of device defects were 98.19% (598/609), 98.36% (598/608), and 1.96% (2/102), respectively, in the test group, and 98.72% (385/390), 98.97% (385/389), and 0.00% (0/103), respectively, in the control group. No significant differences were observed between the test and control groups. In addition, for the Axium coil, 2 cases (2/127, 1.57%) involved the use of the balloon remodeling technique to enhance the effectiveness of embolization. The details are provided in **Supplementary Table 1**.

DISCUSSION

In this prospective randomized controlled open-label multicenter noninferiority study conducted in China, we compared the safety and effectiveness of Gekko and Axium coils in the endovascular treatment of patients with IA. Our findings show that the Gekko coil was comparable to the Axium coil in terms of successful occlusion rate and marginal incidence of adverse events during the embolization of IA, providing robust evidence for the safety and effectiveness of the Gekko coil in the treatment of IA.

Our trial has shown that the successful occlusion at the 6-month follow-up was 96.08% and 96.12% for the Gekko and Axium coils, respectively. These results surpassed those reported in previous trials, such as CCT (Cerecyte Coil Trial) and MAPS (Matrix and Platinum Science).[5,10] CCT reported the successful occlusion rate of 59% in the Cerecyte and 54% in the bare platinum coil group at 6 months follow-up. A recent study based on the MAPS trial[11] highlighted the importance of achieving Raymond class I and II occlusion because it is associated with a decreased risk of delayed hemorrhage. Our trial showed no cases of rebleeding at the 6- and 12-month follow-up, suggesting a potentially reduced risk of delayed hemorrhage in our patient cohort. However, long-term follow-up is warranted to substantiate this finding.

Coil embolization is one of the methods used to treat both ruptured and unruptured IA, but the relatively high recanalization rate after coil embolization remains a significant drawback.[12] In this study, the recanalization rate rates were 2.02% in the test group and 1.96% in the control group, indicating a reduced recanalization rate compared with randomized controlled trials of other coil systems. These results highlight the potential of the Gekko coil in minimizing the risk of recanalization[5,13-15]

As an essential strategy of endovascular treatment, coil embolization has gained wide use, and various types of coils have been developed for this purpose.[16] The Gekko coil stands out as a soft mechanical detachable coil with advantages such as a shorter detaching zone; smaller deflection angle of microcatheter (**Supplementary Figure 2**); smaller friction force with microcatheter (**Supplementary Figure 3**); improved access to narrow space; less pressure on the aneurysm wall; better compliance with the shape for irregular, ruptured, and small aneurysms; as well as safe and dense packing. All major preclinical studies including product design, quality inspection, and risk analysis in animals, have all been successfully completed for the Gekko coil. In this clinical study, after integrating the Likert score data calculated by the pushing, filling, withdrawal, and detachable performance of the device based on per-protocol analysis, the researchers' satisfaction rate with the device was 98.36% (598/608) and 98.97% (385/389) in the test and control group, respectively. The Gekko mechanical detachable method allows for instant detachability, stability, and reliability, is simple to use, and can achieve a success rate of 99.7%.

Several bare-metal coil types, including Axium, Target, Orbit, and MicroFlex coils, are available for clinical use, each with its

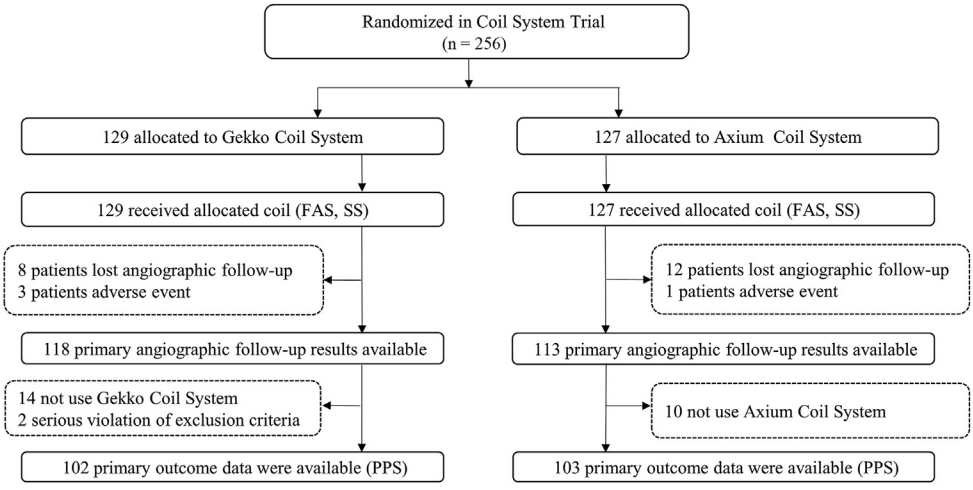

Figure 1. Trial profile. FAS, full analysis set; PPS, per-protocol set; SS, safety set.

Table 1. Baseline Characteristics of the Intention-To-Treat Population

	Gekko Coil, n = 129 (%)	Axium Coil, n = 127 (%)	*P* Value
Gender			0.441
Female	95(73.64)	88 (69.29)	
Male	34 (26.36)	39 (30.71)	
Age (years)	56.97 ± 10.13	58.39 ± 9.02	0.239
Medical history, n (%)			
Allergic history	12 (9.30)	11 (8.66)	0.858
Unstable coronary heart disease	0 (0.00)	1 (0.79)	0.496
Other previous history and medical history	97 (75.19)	108 (85.04)	0.049
Baseline rupture status, n (%)			0.458
Yes	46 (35.66)	51 (40.16)	
No	83 (64.34)	76 (59.84)	
Total (missing)	129 (0)	127 (0)	
H-H grade of ruptured aneurysms patients, n (%)			0.399
I	15 (11.63)	20 (15.75)	
II	24 (18.60)	24 (18.90)	
III	7 (5.43)	7 (5.51)	
Inapplicable	83 (64.34)	76 (59.84)	
Total (Missing)	129 (0)	127 (0)	
Aneurysm location, n (%)			0.255
Anterior			0.543
Internal carotid artery	96 (82.76)	93 (78.81)	
Anterior cerebral artery	8 (6.90)	13 (11.02)	
Middle cerebral artery	12 (10.34)	12 (10.17)	
Total	116 (90.63)	118 (94.40)	
Posterior			0.336
Vertebral artery	1 (8.33)	1 (14.29)	
Basilar artery	4 (33.33)	0 (0.00)	
Posterior cerebral artery	7 (58.33)	6 (85.71)	
Total	12 (9.38)	7 (5.60)	
Total (missing)	128 (1)	125 (2)	
Target aneurysm size (mm)	6.53 ± 3.28	6.37 ± 3.34	0.455
Total (missing)	129 (0)	127 (0)	
Assist device used, n (%)			0.966
Balloon	0 (0.00)	2 (1.57)	0.539
Stent	85 (65.89)	79 (62.20)	0.245
Double microcatheter	1 (0.78)	5 (3.94)	0.118

unique characteristics in terms of structure, softness, transportability, ease of use, and so on.[7,9] Softness is an essential indicator in achieving effective aneurysm filling, which is determined by the interaction of various physical properties of the metal, including the coil stiffness parameter. The stiffness parameter, determined by the constant (k), correlates with the force required to compress the coil. Therefore, a smaller k-value indicates a softer coil with improved flexibility.[17,18] Coils with

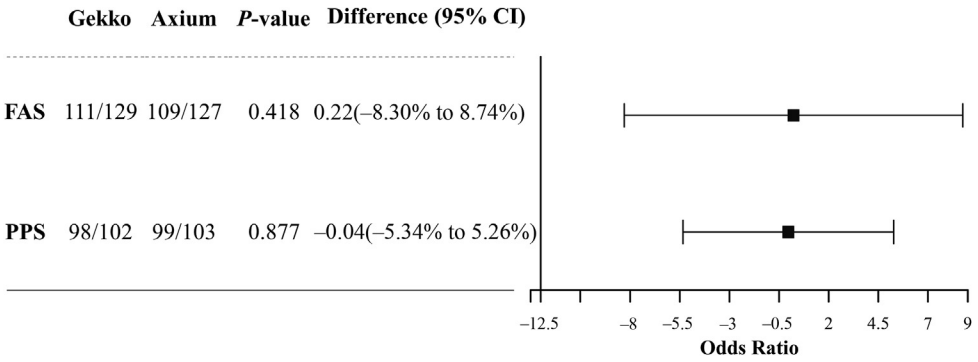

Figure 2. Noninferiority difference of Gekko Coil System. CI, confidence interval; FAS, full analysis set; PPS, per-protocol set.

Table 2. Initial and Follow-Up Angiographic Outcome Based on the Core Laboratory Assessed

	Modified Intention-To-treat			Per-Protocol Analysis		
	Gekko Coil, n = 129, n (%)	Axium Coil, n = 127, n (%)	*P* Value	Gekko Coil, n = 102, n (%)	Axium Coil, n = 103, n (%)	*P* Value
Immediate Raymond scores			0.190			0.213
I	82 (64.57)	75 (60.00)		67 (67.00)	63 (61.76)	
II	28 (22.05)	23 (18.40)		19 (19.00)	16 (15.69)	
III	17 (13.39)	27 (21.60)		14 (14.00)	23 (22.55)	
Total (missing)	127 (2)	125 (2)		100 (2)	102 (1)	
Immediate successful occlusion			0.086			0.116
Yes	110 (86.61)	98 (78.40)		86 (86.00)	79 (77.45)	
No	17 (13.39)	27 (21.60)		14 (14.00)	23 (22.55)	
Total (missing)	127 (2)	125 (2)		100 (2)	102 (1)	
6 months Raymond scores			0.836			0.782
I	97 (84.35)	95 (84.82)		87 (87.00)	88 (86.27)	
II	14 (12.17)	14 (12.50)		11 (11.00)	11 (10.78)	
III	4 (3.48)	3 (2.68)		2 (2.00)	3 (2.94)	
Total (missing)	115 (14)	112 (15)		100 (2)	102 (1)	
6 months successful occlusion			0.418			0.877
Yes	111 (86.05)	109 (85.83)		98 (96.08)	99 (96.12)	
No	18 (13.95)	18 (14.17)		4 (3.92)	4 (3.88)	
Total (missing)	129 (0)	127 (0)		102 (0)	103 (0)	
6 months recanalization rate			0.683			1.000
Yes	4 (3.51)	2 (1.79)		2 (2.02)	2 (1.96)	
No	110 (96.49)	110 (98.21)		97 (97.98)	100 (98.04)	
Total (missing)	114 (15)	112 (15)		99 (3)	102 (1)	

Table 3. Clinical Outcome of Patients at 6 and 12 Months Follow-Up in the Intention-To-Treat Population

	Gekko Coil, n = 129, n (%)	Axium Coil n = 127, n (%)	*P* Value
6 months rebleeding rate			
Yes	0 (0.00)	0 (0.00)	—
No	118 (100.00)	113 (100.00)	
Total (missing)	118 (11)	113 (14)	
12 months rebleeding rate			
Yes	0 (0.00)	0 (0.00)	—
No	110 (100.00)	113 (100.00)	
Total (missing)	110 (19)	113 (14)	
Baseline mRS score			
0	86 (66.67)	86 (67.72)	0.579
1	26 (20.16)	29 (22.83)	
2	17 (13.18)	12 (9.45)	
Total (missing)	129 (0)	127 (0)	
6 months follow-up mRS score			
0	100 (84.75)	101 (88.60)	0.259
1	16 (13.56)	13 (11.40)	
2	2 (1.69)	0 (0.00)	
Total (missing)	118 (11)	114 (13)	
12 months follow-up mRS score			
0	101 (89.38)	104 (91.23)	0.516
1	11 (9.73)	10 (8.77)	
2	1 (0.88)	0 (0.00)	
Total (missing)	113 (16)	114 (13)	

mRS, modified Rankin Scale.

Table 4. Summary of Serious Adverse Events within 12 Months in the Intention-To-Treat Population

	Gekko Coil, n = 129, n (%)	Axium Coils, n = 127, n (%)	*P* Value
All SAEs	16 (12.40)	21 (16.54)	0.378
Device-related SAEs	0 (0.00)	0 (0.00)	—
Neurologic complications	13 (10.08)	13 (10.24)	0.964
Symptomatic cerebral infarction or thrombosis	5 (3.88)	6 (4.72)	0.738
Symptomatic intracranial hemorrhage	1 (0.79)	2 (1.55)	0.552
Aneurysm rupture or rebleeding	0 (0.00)	0 (0.00)	1.000
Others (e.g., hydrocephalus)	4 (3.10)	3 (2.33)	0.717
Death	3(2.33)	2(1.57)	1.000
Device-related	0 (0.00)	0 (0.00)	—

SAE, serious adverse event.

thinner primary wire and larger diameter have greater filling volume and softness.[19] In the early product performance test, the deformation force of the Gekko coil was 51% that of the Axium coil, suggesting better flexibility and a more robust ability to fill aneurysms. Our results support this notion, and we believe that the softness of the Gekko coil compared with the Axium coil may contribute to a reduced risk of procedure-related complications. The difference in the incidence of procedure-related complications was −3.91, which was not statistically significant.

Moreover, a limitation of our study is the nonavailability of primary outcome data for 24 patients (14 in the test group and 10 in the control groups) in FAS analysis. To address this limitation, a sensitivity analysis was performed for an additional 24 patients with missing primary outcome data. The 6 months successful occlusion rate of the test group was 93.10% (108/116), whereas the control group was 96.46% (109/113), showing the difference of successful occlusion rate was −3.36% (95% CI, −9.09% to 2.38%; P = 0.376). The lower limit of 95% CI was higher than the noninferiority boundary −12%, further supporting the noninferiority of the Gekko coil to the Axium coil.

CONCLUSIONS

This trial showed that the Gekko coil was noninferior to the Axium coil in achieving successful occlusion rates and marginal occurrence of SAEs in the endovascular treatment of IA. This finding highlights the Gekko coil as a safe and effective alternative for treating patients with IA in clinical practice. However, further analysis of long-term follow-up is warranted to validate the durability and long-term outcomes of coil embolization using the Gekko coil. In addition, postmarketing real-world studies are crucial for gathering more comprehensive experience and evaluating the effectiveness of the Gekko coil in routine clinical practice.

ADVANCES IN KNOWLEDGE

1. The Gekko coil system is a novel supersoft mechanical detachable bare-metal coil with a smaller coefficient (k) and primary wire diameter, designed to improve successful aneurysm occlusion rate.
2. The study provides evidence supporting the safety and efficacy of the Gekko coil system in clinical practice.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Guoli Duan: Conceptualization, Data curation, Formal analysis, Methodology, Writing — original draft. **Yuhang Zhang:** Formal analysis, Investigation, Methodology, Resources, Validation, Writing — original draft. **Qiang Li:** Conceptualization, Investigation, Methodology, Writing — review & editing. **Pengfei Yang:** Conceptualization, Funding acquisition, Methodology, Validation, Writing — review & editing. **Jianmin Zhang:** Data curation, Supervision. **Honglei Wang:** Data curation, Supervision. **Jun Ma:** Data curation, Validation. **Sheng Guan:** Data curation, Supervision. **Zhian Han:** Data curation, Supervision. **Hua Yang:** Data curation, Supervision. **Haibin Shi:** Data curation, Supervision. **Yunhui Liu:** Data curation, Validation. **Chuansheng Liang:** Data curation, Supervision. **Xin Wu:** Data curation, Supervision. **Yina Wu:** Conceptualization, Data curation, Methodology. **Qiao Zuo:** Data curation, Methodology, Supervision. **Zhengzhe Feng:** Resources, Software, Validation. **Lei Zhang:** Conceptualization, Project administration, Supervision. **ZiFu Li:** Data curation, Investigation, Supervision. **Yu Zhou:** Conceptualization, Data curation, Methodology. **Dongwei Dai:** Conceptualization, Data curation, Resources, Validation. **Yibin Fang:** Conceptualization, Data curation, Funding acquisition, Resources, Supervision. **Qinghai Huang:** Data curation, Supervision, Validation. **Yi Xu:** Conceptualization, Project administration, Resources. **Rui Zhao:** Data curation, Resources, Supervision. **Jianmin Liu:** Conceptualization, Investigation, Methodology, Project administration, Resources, Supervision.

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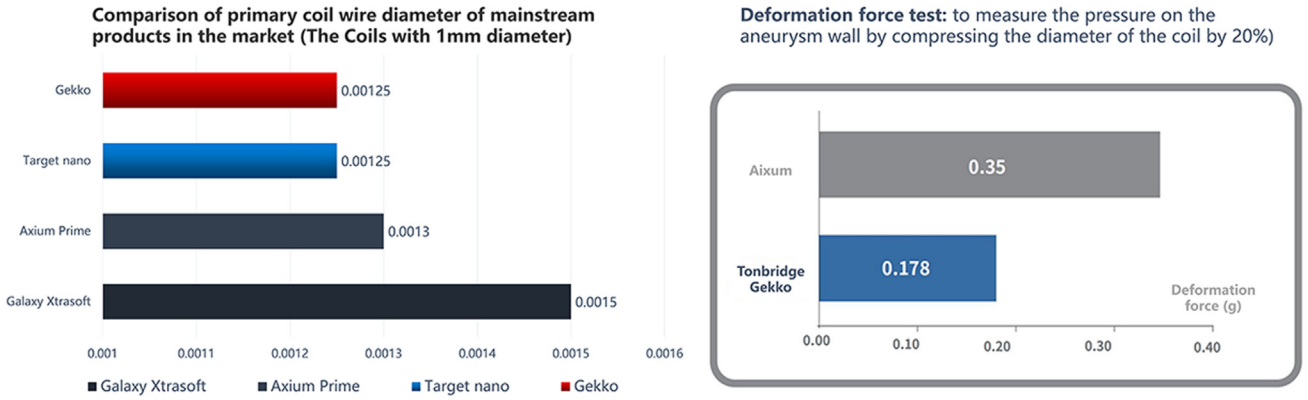
- **The primary coil wire diameter of Tonbridge Gekko is 0.00125" , which is the smallest in mainstream market.**
- **The coils with platinum tungsten alloy wire and finer primary coil wire diameter make operation more flexible and better embolization results.**



Supplementary Figure 1. Super soft and deformation force test.

Gekko: Shorter detaching zone

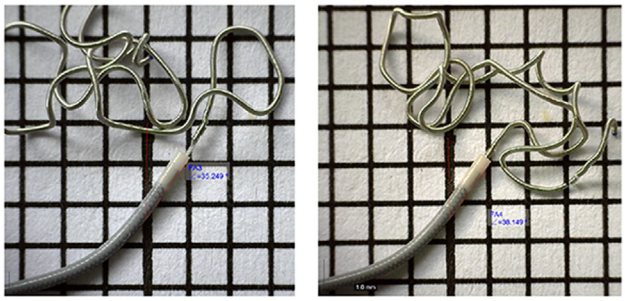
The length of Gekko detaching zone: 1.43mm

Brand	The length of detaching zone
Tonbridge Gekko	1.43mm
Axium	1.52mm

Finer anti-unwinding wire is, the shorter release area and smaller deflection angle of microcatheter are.

Microcatheter deflection test:

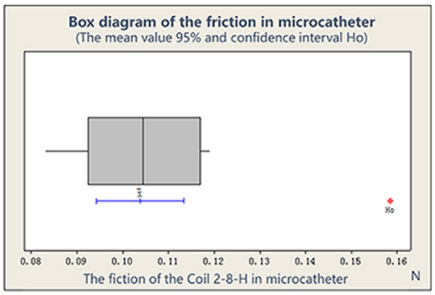
to measure the maximum deflection angle on the microcatheter when pushing out the coil.

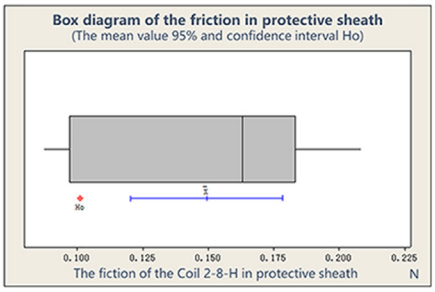


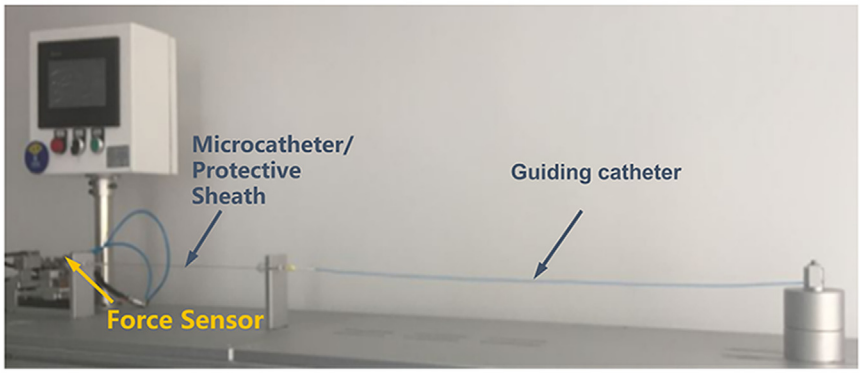
Gekko (35.25°) Axium (38.15 °)

Supplementary Figure 2. Detaching zone and microcatheter deflection test.

To measure the friction resistance of coils when moving inside the microcatheter and protective sheath.







The test results show that:

- In the microcatheter, the friction force of AXIUM is significantly greater than that of Tonbridge Gekko.
- In the protective sheath, the friction force of Tonbridge Gekko is slightly greater than that of AXIUM.
- In total, the frictions of coils in two brands are far less than the standard requirements.

Supplementary Figure 3. Friction Test.

Supplementary Table 1. Summary of Operator Satisfaction Rate

	Modified Intention-to-Treat			Per-Protocol Analysis		
	Gekko Coil, n = 129, n (%)	**Axium Coil, n = 127, n (%)**	***P* Value**	**Coil System, n = 102, n (%)**	**Axium Coil, n = 103, n (%)**	***P* Value**
Successful device placement			0.513			0.520
Yes	734 (98.52)	475 (98.96)		598 (98.19)	385 (98.72)	
No	11 (1.48)	5 (1.04)		11 (1.81)	5 (1.28)	
Total (missing)	745 (0)	480 (0)		609 (0)	390 (0)	
Push performance			0.377			<0.001
N (missing)	744 (1)	479 (1)		608 (1)	389 (1)	
Mean (SD)	4.81 (0.46)	4.80 (0.41)		4.89 (0.42)	4.83 (0.40)	
Filling performance			0.622			0.004
N (missing)	742 (3)	478 (2)		606 (3)	388 (2)	
Mean (SD)	4.82 (0.45)	4.82 (0.38)		4.90 (0.40)	4.85 (0.35)	
Fallback performance			0.148			<0.001
N (Missing)	744 (1)	479 (1)		608 (1)	389 (1)	
Mean (SD)	4.82 (0.45)	4.80 (0.40)		4.90 (0.40)	4.83 (0.38)	
Release performance			0.007			0.008
N (missing)	737 (8)	475 (5)		601 (8)	385 (5)	
Mean (SD)	4.82 (0.49)	4.77 (0.42)		4.85 (0.49)	4.82 (0.39)	
Likert score			0.176			0.008
N (missing)	744 (1)	479 (1)		608 (1)	389 (1)	
Mean (SD)	19.22 (1.84)	19.15 (1.64)		19.47 (1.75)	19.26 (1.58)	
Satisfactory operation			0.414			0.420
Yes	10 (1.34)	4 (0.84)		10 (1.64)	4 (1.03)	
No	734 (98.66)	475 (99.16)		598 (98.36)	385 (98.97)	
Total (missing)	744 (1)	479 (1)		608 (1)	389 (1)	
Device defect			0.498			0.246
Yes	2 (1.55)	0 (0.00)		2 (1.96)	0 (0.00)	
No	127 (98.45)	127 (100.00)		100 (98.04)	103 (100.00)	
Total (missing)	1290)	127 (0)		102 (0)	103 (0)	

SD, standard deviation.