| **Section and Topic** | **Item #** | **Checklist item** | **Location where item is reported** |
| --- | --- | --- | --- |
| **TITLE** | | |  |
| Title | 1 | The report is identified as a meta-analysis | 1 |
| **ABSTRACT** | | |  |
| Abstract | 2 | **Background** Radiofrequency ablation is one of the important methods for treating atrial fibrillation (AF). This study systematically evaluates the effectiveness and safety of two catheter radiofrequency ablation approaches: high-power short-duration (HPSD) and traditional low-power long-duration (LPLD), in treating atrial fibrillation.  **Methods** Original prospective studies (eight cohort studies and three randomized controlled trial studies) evaluating the effect of HPSD on AF recurrence, occurrence rate of complications, and procedural time in AF patients were searched in four specific databases from the establishment of the databases to March 2023. We utilized RevMan 5.20 and Stata 11.0 statistical software for conducting the meta-analysis. Publication bias was assessed using funnel plots and Egger's test. （Higgins et al., Statistics in Medicine; 2003, BMJ）The effect estimates were synthesized as relative risks (RR) or standardized mean differences (SMD) along with their corresponding 95% confidence intervals (CI).  **Results** A total of 536 relevant literatures were retrieved, while eleven prospective studies were collected. The combined value of the estimated effect of HPSD vs. LPLD treatment on AF recurrence in patients with AF was [RR=0.59, 95% CI (0.45, 0.78); P<0.001], the effect of HPSD vs. LPLD treatment on procedural time in patients with AF was [SMD=-1.17, 95% CI (-1.56, -0.77); P<0.001 ], while the effect of HPSD vs. LPLD treatment on esophageal thermal injury in patients with AF was [RR=0.84, 95% CI (0.22, 3.28); P=0.80]. Notably, the combined value of the estimated effect of HPSD vs. LPLD treatment on other major complications (steam pop) in patients with AF was [RR=0.57, 95% CI (0.22, 1.47); P=0.24].  **Conclusion** In summary, HPSD is more effective than traditional LPLD strategies, with a lower recurrence rate of atrial fibrillation after surgery. Meanwhile, HPSD strategy can improve surgical efficiency with a shorter procedural time than LPLD strategy.  **Keywords:** radiofrequency ablation; atrial fibrillation; efficacy; complications; meta analysis | 1 |
| **INTRODUCTION** | | |  |
| Rationale | 3 | Atrial fibrillation (AF) is one of the most common tachyarrhythmia. The latest results of epidemiological research indicate that the crude prevalence rate of atrial fibrillation in China is 2.3% with regional differences.Atrial fibrillation (AF) is one of the most common tachyarrhythmia. Radiofrequency ablation is one of the important methods for catheter ablation of atrial fibrillationNew radiofrequency ablation strategies for HPSD have been widely used in animal models and clinical studies. Compared to the traditional low power long duration (LPLD) strategy, HPSD can generate shallow and large area damage by increasing the impedance of the damaged core and reducing the damage caused by conduction heat generation. Now the results of studies on the efficacy of radiofrequency ablation of HPSD for AF are inconsistent | 1 |
| Objectives | 4 | This study included the latest original study comparing HPSD and traditional LPLD strategies in catheter ablation of atrial fibrillation, and conducted a meta-comparison of multiple endpoints in terms of effectiveness, safety, and surgical efficiency of the two strategies,in order to provide a reference for the selection of catheter ablation strategies for atrial fibrillation.In addition, this study statistically analyzed the recurrence rate of postoperative atrial fibrillation and the recurrence rate of atrial fibrillation/atrial tachycardia (atrial tachycardia), respectively, to explore the heterogeneity of efficacy in patients with atrial fibrillation | 2 |
| **METHODS** | | |  |
| Eligibility criteria | 5 | Inclusion: (1) randomized clinical trial (RCT) evaluating the effect of HPSD on AF and atrial tachycardia/atrial flutter (AT/AFL) recurrence, occurrence rate of complications, and procedural time and published from the database to March 2023; (2) the study patients in original article were clinically diagnosed as AF; (3) studies employed LPLD treatment as control group; (4) original articles contents should include accurately comprehensive statistical stata: sample size, number of AF and AT/AFL recurrence, occurrence rate of complications, and procedural time. | 2 |
| Information sources | 6 | Four unique databases, including PubMed, Cochrane Library, Web of Science database and Medline | 2 |
| Search strategy | 7 | (Atrial Fibrillations OR Fibrillation, Atrial OR Fibrillations, Atrial OR Auricular Fibrillation OR Auricular Fibrillations) AND (Ablation, Radiofrequency OR Ablation, Radiofrequency OR Ablation, Radio Frequency OR Radio-Frequency Ablation OR Ablation, Radio-Frequency) | 2 |
| Selection process | 8 | Inclusion: (1) randomized clinical trial (RCT) evaluating the effect of HPSD on AF and atrial tachycardia/atrial flutter (AT/AFL) recurrence, occurrence rate of complications, and procedural time and published from the database to March 2023; (2) the study patients in original article were clinically diagnosed as AF; (3) studies employed LPLD treatment as control group; (4) original articles contents should include accurately comprehensive statistical stata: sample size, number of AF and AT/AFL recurrence, occurrence rate of complications, and procedural time. Exclusion criteria: (1) non-clinical study; (2) incomplete literature data; (3) repeated reports of literature; (4) not find clear outcome observation indicators. Only English language articles were applied. | 2 |
| Data collection process | 9 | According to the same inclusion and exclusion criteria, the process of screening study were completed by two reviewers independently. If there is a disagreement, the two reviewers discuss and negotiate with third participant to resolve it. | 2 |
| Data items | 10 | We aim to extract the following datas: the number of HPSD group and LPLD group, outcomes (AF and AT/AFL recurrence, occurrence rate of complications, and procedural time) as well as the name of first author, the time of publication. | 2 |
| Study risk of bias assessment | 11 | Study risk of bias assessment not described, see Table 2 | 5 |
| Effect measures | 12 | We used the Newcastle Ottawa Scale[10] to assess the methodological quality of the included papers. The evaluation criteria covered several aspects, including adequate case definition, representativeness of cases, selection of controls, definition of controls, ascertainment of exposure, and using the same method of ascertainment for both cases and controls, as well as non-response rate.  For RCT studies, we evaluated their quality and methodology using the Jadad scale, which assigns a higher score (total score of 7) to trials with more rigorous methodological design | 3 |
| Synthesis methods | 13 | RevMan 5.20 software (Cochrane Collaboration, London, United Kingdom) was used to conduct meta analysis. The effect estimates were pooled by relative risk (RR) or standardized mean difference (SMD) with 95% CI. The heterogeneity of the researches collected in this meta-analysis was calculated using Q-test and I2-test. Meanwhile, if P> 0.100 and I2< 50%, it was indicated that there was low heterogeneity across the included studies, so fixed effect model was conducted to combine merge RR or SWD with 95% CI; otherwise, random effect model was employed | 3 |
| Reporting bias assessment | 14 | Egger's test and Begg test were established to detect publication biasv based on Stata software to test for risk of bias | 3 |
| Certainty assessment | 15 | sensitivity analysis of heterogeneity and subgroup analysis of factors that may cause heterogeneity Funnel plot and forest plots was made by using RevMan 5.20 software. | 3 |
| **RESULTS** | | |  |
| Study selection | 16 | In this study 536 relevant articles were retrieved using the inclusion and exclusion criteria, 208 from Pubmed, 104 from the Cochrane Library, 136 from Web Science and 88 from Embase. After excluding duplicate deletion, reading title and abstract exclusion, 11 prospective [11-21] cloning studies were collected,, including 746 cases in HPSD group and 831 in LPLD group. Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. | 3 |
| Study characteristics | 17 | Castrejón-Castrejón S 2020[11];Ejima K 2020[12];Kottmaier M 2020[13];Kumagai K 2020[14];Okamatsu H 2019[15];Pambrun T 2019[16];Shin DG 2020[17];Wielandts JY 2021[18];Yavin HD 2020[19];Berte B 2019[20];Kaneshiro T 2020[21].See table 1 for details | 4 |
| Risk of bias in studies | 18 | Risk of bias in studies not described,see Table 2 | 5 |
| Results of individual studies | 19 | The combined value of the estimated effect of HPSD vs. LPLD treatment on AF recurrence in patients with AF was [RR=0.59, 95% CI (0.45, 0.78); P<0.001], the effect of HPSD vs. LPLD treatment on procedural time in patients with AF was [SMD=-1.17, 95% CI (-1.56, -0.77); P<0.001 ], while the effect of HPSD vs. LPLD treatment on esophageal thermal injury in patients with AF was [RR=0.84, 95% CI (0.22, 3.28); P=0.80]. Notably, the combined value of the estimated effect of HPSD vs. LPLD treatment on other major complications (steam pop) in patients with AF was [RR=0.57, 95% CI (0.22, 1.47); P=0.24]. | 6-11 |
| Results of syntheses | 20a | Characteristics are shown in Table 1 | 8 |
| 20b | The combined value of the estimated effect of HPSD vs. LPLD treatment on AF recurrence in patients with AF was [RR=0.59, 95% CI (0.45, 0.78); P<0.001], the effect of HPSD vs. LPLD treatment on procedural time in patients with AF was [SMD=-1.17, 95% CI (-1.56, -0.77); P<0.001 ], while the effect of HPSD vs. LPLD treatment on esophageal thermal injury in patients with AF was [RR=0.84, 95% CI (0.22, 3.28); P=0.80]. Notably, the combined value of the estimated effect of HPSD vs. LPLD treatment on other major complications (steam pop) in patients with AF was [RR=0.57, 95% CI (0.22, 1.47); P=0.24]. | 6-11 |
| 20c | all investigations of possible causes of heterogeneity among study results not described |  |
| 20d | Except for operation time, other index sensitivity analysis suggested that none of the original studies did not affect the combined effect size | 6-11 |
| Reporting biases | 21 | The funnel plot showed that all points were evenly distributed and symmetrical for outcomes of AF and AT/AFL recurrence, occurrence rate of complications. However, the funnel plot showed that all points were not symmetrical for procedural time The result was (Egger's test; P=0.428, 0.354, 0.526 and 0.628 for AF and AT/AFL recurrence, ETI, and major complications, respectively), suggesting that there was no publication bias, and the results were credible.After Egger's test, the Begg test showed ((Begg test; P= 0.300,0.256,0.427,0.597, and 0.597, respectively), further establishing that no bias occurred | 11 |
| Certainty of evidence | 22 | The sensitivity analysis suggested that the original studies of Berte et al [10] was potential sources of heterogeneity, and that the total operation time in the HPSD group was still significantly shortened compared with the LPLD group（WMD=--38. 33，95%CI：-45. 72~-30. 94，I2=87%，P<0. 00001）After a subgroup analysis, we found that, When the ablation power is 45 W or between 45 and 60 W, The total operation time in the HPSD group was shorter than that in the LPLD group (at power 45 W, WMD=-34.40, 95%CI:-46.10~-22.71, I2 =84%, P<0. 00001; At 45 W <power <60W, WMD=-41.15, 95%CI: -51.16~-31.15, I2=92%, P<0. 00001; However, there was no significant difference between the two subgroups (P=0. 39), And the heterogeneity within the subgroups was still high.. | 8 |
| **DISCUSSION** | | |  |
| Discussion | 23a | The above studies suggest that increasing the power of radiofrequency ablation is theoretically feasible. Subsequently, researchers have tried to introduce the HPSD strategy into clinical radiofrequency ablation of atrial fibrillation. This study confirmed the feasibility of the HPSD strategy in radiofrequency ablation of atrial fibrillation. In all included original studies, 100% of patients in the HPSD group successfully completed the PVI process. This study also confirmed that the HPSD strategy is superior to the traditional LPLD strategy in the effectiveness of radiofrequency ablation of atrial fibrillation, that is, the probability of occurrence of AF after surgery is lower. Therefore, our study suggested that the HPSD strategy was feasible and had better effects than traditional LPLD. In addition, in recent years, teams have gradually attempted to use ultra-high power (70-90 W) short-term strategies for radiofrequency ablation of atrial fibrillation [13,30].  One of the potential advantages of the HPSD strategy is its safety, especially for the thermal injury of the esophagus caused by radiofrequency ablation. The posterior wall of the left atrium is adjacent to the esophagus. Due to individual differences in the course of the esophagus, the shortest distance from the endocardium to the esophageal wall is 3. 5%. The distance between the endocardium and the esophagus at the opening of the pulmonary vein ranges from 3 to 13.5 mm Ranging from 7 to 32.8 mm [31, 32]. The safe and effective range of ablation of the posterior wall of the atrium is narrower, so radiofrequency ablation of the intima corresponding to the weak connective tissue between the atrium and the esophagus (mostly the posterior wall) may cause varying degrees of esophageal thermal damage [33]. As mentioned earlier, the HPSD strategy produces broad and shallow lesions that can theoretically reduce esophageal injury. Our comprehensive study found that there was no significant difference in the incidence of esophageal injury between the HPSD group and the LPLD group. It should be noted that some surgeons will actively reduce power during the ablation of the posterior wall structure of the left atrium. For example, the Leo team [34] used 20 W power in both LPLD and HPSD group during the posterior wall ablation, and the Lee team used 25 W power [35].Reduced posterior wall ablation power may explain the no difference in esophageal damage between the HPSD and LPLD groupsIt is reported that the HPSD group seems to have a tendency to outperform the LPLD group. For example, in the study by Francke et al. [46], 97 patients in the HPSD group experienced 13 cases of esophageal injury. However, except for one deep ulcer, the esophageal lesions in the HPSD group were all small and superficial ulcers, while all 2 cases in the LPLD group were deep ulcers. Leo et al. [36] conducted real-time monitoring of esophageal temperature through temperature detectors during radiofrequency ablation, specifying 39℃ as the alarm temperature. The authors found that the number of times the temperature in the esophagus reached the alarm temperature during radiofrequency ablation in the LPLD group was higher than that in the HPSD group (P=0.026).Because HPSD ablation is based on impedance thermal damage, in the myocardial tissue in a short time completely wall without increasing the deep tissue damage, LPLD ablation mainly depends on conduction heat damage, not completely increase the probability of AF recurrence, or due to long ablation may cause deep adjacent tissue damage, and the LPLD ablation of the catheter stability for a long time, thus affect the ablation effect. | 12 |
| 23b | The limitations of this study include: 1) Only two of the original studies included were randomized controlled studies or randomized non blind controlled studies, while the rest were observational cohort studies; 2) Due to differences in power, ablation time, contact pressure, AI, LSI, and other settings, as well as operational differences between each surgeon, there is heterogeneity between the original studies regarding the outcome of procedural time; 3) Various radiofrequency ablation methods with different proportions were included in various original studies, such as PVI and linear ablation based on PVI, posterior wall box ablation, and tricuspid isthmus ablation for atrial flutter, resulting in heterogeneity among the original studies. (4) Some endpoints may have publication bias. | 13 |
| 23c | Although the ultra-high power strategy was used in this study, an in-depth subgroup analysis of the original studies was difficult due to the limited number of them, which was only performed between operative time and power. Therefore, it is necessary to further investigate whether the increased power can improve its therapeutic effect. | 13 |
| 23d | In summary, in the treatment of atrial fibrillation with radiofrequency ablation, HPSD is more effective than traditional LPLD strategies, with a lower recurrence rate of atrial fibrillation after surgery; The safety of HPSD was similar to that of LPLD, and there was no significant difference in the incidence of esophageal injury between the two groups. HPSD strategy can improve surgical efficiency with a shorter procedural time than LPLD strategy.The shortened time of HPSD ablation means that it can reduce the time of wearing lead clothing, relieve the long-term load damage, reduce the physical injury caused by X-ray exposure to medical staff and patients, and reduce the risk of anesthesia and discomfort during long-term ablation. However, in future studies, we need to continue the validation of other indicators, such as PVI time and acute pulmonary vein conduction recovery rate, so order to ensure comprehensiveness. | 13 |
| **OTHER INFORMATION** | | |  |
| Registration and protocol | 24a | Provide registration information for the review, including register name and registration number, or state that the review was not registered. |  |
| 24b | Indicate where the review protocol can be accessed, or state that a protocol was not prepared. |  |
| 24c | Describe and explain any amendments to information provided at registration or in the protocol. |  |
| Support | 25 | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. |  |
| Competing interests | 26 | Declare any competing interests of review authors. |  |
| Availability of data, code and other materials | 27 | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. |  |

*From:*  Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

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