Int J Clin Exp Med 2016;9(6):10344-10353
www.ijcem.com /ISSN:1940-5901/IJCEM0028998

Original Article

Efficacy of prophylactic ciprofloxacin administered in transrectal prostate biopsy: a meta-analysis

Yu Ding[1*], Xueya Yao[2*], Shangping Fang[3*], Chengbao Li[2], Xinyu Ge[2], Fengying Xu[3], Lei Huang[1], Xiaodi Yan[3]

[1]Company 12, Second Military Medical University, China; [2]Hebei North University School of Medicine, China; [3]Department of Anesthesiology, Changzheng Hospital, Second Military Medical University, China. [*]Equal contributors.

Received March 23, 2016; Accepted May 10, 2016; Epub June 15, 2016; Published June 30, 2016

Abstract: Purpose: Ciprofloxacin, one of quinolinones, is prophylactic used in transrectal prostate biopsy widely, but there are still few valid evidences about the effects of the antibiotic. The meta-analysis was aimed to assess the efficacy of ciprofloxacin compared with placebo and other agents used as prophylaxis in transrectal prostate biopsy. The comparison of single dose and multiple dose regimes was conducted in the meta-analysis. Methods: PubMed, EMBASE, Cochrane Library and VIP were searched for relevant studies. A meta-analysis of randomized controlled trials (RCTs) meeting the criteria was performed using Review Manager. Results: Nineteen trials involving 4,083 participants were included in this meta-analysis. Ciprofloxacin was more effective than placebo (RR 0.39; 95% CI 0.27, 0.57; $p < 0.00001$) and other antibiotics (RR 0.52; 95% CI 0.36, 0.76; $p = 0.0006$) for the prevention of infectious complications. For different regimes of ciprofloxacin, single dose of ciprofloxacin was less effective than multiple dose regime (RR 1.78; 95% CI 1.13, 2.80; $p = 0.01$). Conclusions: The prophylactic use of ciprofloxacin in transrectal prostate biopsy has statistically significant advantages over placebo and other antibiotics. Meanwhile, multiple dose regimes show more effective in the prevention of infectious complications of prostate biopsy than single dose of ciprofloxacin.

Keywords: Ciprofloxacin, transrectal prostate biopsy, infectious complications, antibiotics

Introduction

The use of prostate biopsy has increased dramatically with the use of prostate specific antigen screening for prostate cancer. Transrectal prostate biopsy, one of the most commonly performed urologic procedures, is generally considered as a safe procedure, but infectious complications secondary to biopsy are some of the most common adverse events encountered in practice [1]. Currently, many urologists use prophylactic antibiotic therapy to minimize the infectious complications after the biopsy, but such therapy does not completely eliminate infection. Meanwhile, prophylactic strategies differ between institutions and urologists, with variations seen in classes of antimicrobial agents used, duration of use and bowel preparation regimens employed [2]. The reported infection rate varies considerably in studies using different antibiotic regimens [3, 4]. Infectious complications lead to long hospital stays, prolong the time of starting adjuvant therapy and increase health expenditure [5]. Effective prevention of infection has become an imperative step for medical staff.

Numerous studies have shown that the prophylactic administration of quinolinones reduces the incidence of infectious complications after transrectal prostate biopsy [6, 7]. Ciprofloxacin is one of second-generation, broad-spectrum quinolinones with bactericidal activity against Gram-positive and Gram-negative organisms, including those resistant to penicillins, cephalosporins, and aminoglycosides [8] and it has been widely used to prevent infection in the biopsy. It has also been used to treat infections including bone and joint infections, intra-abdominal infections, certain types of infectious diarrhea, respiratory tract infections, skin infections, typhoid fever, and urinary tract infectionsamong others [9].

The effects of ciprofloxacin in transrectal prostate biopsy have been widely evaluated. How-

ever, there is controversy over its efficacy on the prevention of infections in the biopsy compared with other antibiotics and the most optimal regime of ciprofloxacin prophylactic administered in the procedure remains unclear. For example, one study in 2003 [10] showed that ciprofloxacin was more effective than piperacillin/tazobactam in the prevention of infectious complications in patients undergoing prostate biopsy, while another research showed that there were no significant differences on the incidence of infectious complications between ciprofloxacin and other antibiotics [3]. In addition, several studies [11, 12] showed the contradictory conclusions of the comparison between different regimes of ciprofloxacin. Aiming to provide solid conclusions for ciprofloxacin used as prophylaxis in transrectal prostate biopsy, we undertook this meta-analysis to evaluate the efficacy of ciprofloxacin compared with placebo and other antibiotics in patients undergoing prostate biopsy, and different regimes of ciprofloxacin administered was compared as well.

Materials and methods

Search strategy

The following databases were reviewed by two reviewers: PubMed, EMBASE, Cochrane Library, VIP. Additional relevant cited references were identified from the retrieved papers and review articles. The range of the search was from January, 1981 to December, 2015. No language restrictions were used. Search terms included 'transrectal prostate biopsy', 'ciprofloxacin', 'quinolinone', 'antibiotics' and 'randomized controlled trial (RCT)'.

Study selection

The study selection was pre-established. Inclusion criteria: (1) RCTs; (2) Patients undergoing transrectal prostate biopsy; (3) The administration of ciprofloxacin for experimental group and placebo or other antibiotics for control group, or different regimes of ciprofloxacin administrated for two groups; (4) The presence and absence of infectious complications reported as outcomes. Exclusion criteria: (1) Abstracts only; (2) Patients allergic to antibiotics or other contradictions of antibiotics; (3) Duplications; (4) Missing data; (5) Incorrect statistical analysis performed in the report; (6) Treatment of infection rather than prophylaxis. Studies using additional agents, such as metronidazole, were also included.

Data retrieval

Data extracted from the papers included: title, name of the first author, publication year, the design of the trial, the details of antibiotic administration, the duration of follow-up, number of patients in each arm, number of study centers, definition of end points, and the number of end point infection.

Qualitative assessment

The quality of all the included studies was appraised using the guidelines recommended by the Cochrane Collaboration [13]. The risk of bias was evaluated in six categories: randomization and sequence generation, blinding method, allocation concealment, incomplete outcome data, selective outcome reporting, and other sources of bias. Every category was assessed according to three rulings: low risk, unclear risk, and high risk. The items of randomization and sequence generation, blinding method, and allocation concealment were considered as key domains and the evaluation was as follows: low risk of bias (low risk of bias for all key domains); unclear risk of bias (unclear risk of bias for one or more key domains); and high risk of bias (high risk of bias for one or more key domains). Data were independently reviewed by two people. Final inclusion of articles was determined by consensus.

Statistical analysis

The effect of ciprofloxacin on infectious complications, compared with placebo and other antibiotics, and the comparison between different regimes of ciprofloxacin were estimated by calculating pooled Risk Ratio (RR) and its 95% confidence intervals (CI) of the incidence of infectious complications as dichotomous data. The significance of RR overall effect was determined by Z test ($P < 0.05$ was considered statistically significant). A fixed effects model was used when $I^2 \leq 50\%$, otherwise, a random effects model was adopted. A sensitivity analysis was performed to assess whether inclusion of the high-risk studies could significantly bias the result. It was conducted according to high and not high risk of bias (including low and unclear risk of bias). Funnel plot was conducted

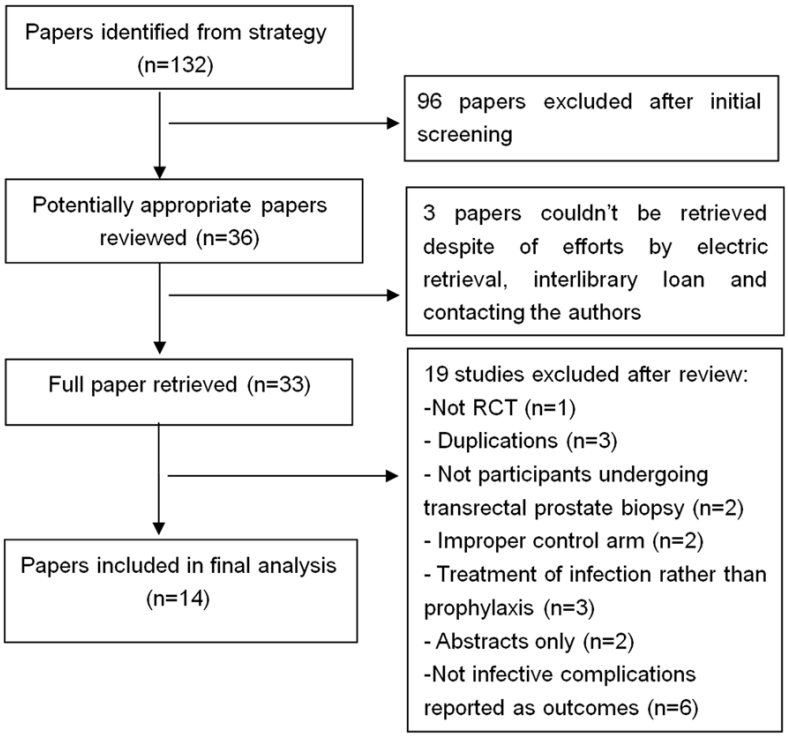

Figure 1. The diagram showing studies eligible for inclusion in the meta-analysis.

to check for publication bias. Statistical analysis was performed with Review Manager (RevMan®) (Version 5.0.; The Cochrane Collaboration, Oxford, UK).

Results

Study selection

As shown in the flow diagram (**Figure 1**), the search of PubMed, EMBASE, Cochrane Library, VIP and reference lists yielded 132 articles. Totally 96 papers were discarded after initial screening. Three full texts [14-16] of the remaining 36 papers couldn't be retrieved despite of efforts by electric retrieval, interlibrary loan and contacting the authors. The remaining 33 papers were carefully read and 19 articles were excluded because they did meet the criteria. Specifically, one paper [17] was excluded because it was not RCT and three [18-20] were excluded because they were duplications. Two papers [21, 22] were excluded because the participants were not undergoing transrectal prostate biopsy. Two papers [23, 24] were excluded because of improper control arm. Three papers [25-27] were excluded because that ciprofloxacin was used for treatment of infection rather than prophylaxis. Two papers [28, 29] were excluded because there were only abstracts, and six papers [4, 30-34] were excluded because of no infectious complications reported as outcomes. Finally, the 14 papers, including 19 RCTs, met the selection criteria.

Study characteristics

Of all the included papers, two were published in Chinese [35, 36]. And one was in Spanish [37]. The remaining 11 papers were published in English. In these included 19 RCTs, 4,083 patients were involved. Characteristics of the included trials are shown in **Table 1**.

Risk of bias within studies

Of the 19 RCTs included, no trial had high risk of bias in blinding method, while one trial [38] had high risk of bias in randomization and one [38] had high risk of bias in allocation concealment. Totally one trial [38] was evaluated as high risk and 18 were unclear risk. An overview of the risk of bias is summarized in **Table 1**.

Results of meta-analysis

Ciprofloxacin verse placebo: Four trials [6, 7, 35, 36], involving 959 participants, compared ciprofloxacin with placebo in preventing infectious complications. Obviously, ciprofloxacin in transrectal prostate biopsy has statistically significant advantages over placebo (RR 0.39; 95% CI 0.27, 0.57; $p < 0.00001$) with $I^2 = 15\%$ (**Figure 2**).

Ciprofloxacin verse other antibiotics: Six trials [3, 10, 38-40] involving 1408 participants, compared ciprofloxacin with other antibiotics. Ciprofloxacin was more effective than other antibiotics (RR 0.52; 95% CI 0.36, 0.76; $p = 0.0006$) for the prevention of infectious complications with $I^2 = 21\%$ (**Figure 3**). One trial with high risk of bias was included in these six trials and the result was unchanged when sensitivity

Table 1. Summary of trials included in the meta-analysis

Author	Year	Center	The duration of follow-up	Number of patients in the experimental group	Interventions in the experimental group	Number of patients in the control group	Interventions in the control group	Outcomes	Risk of bias						Rank
									R	B	A	C	F	O	
Agbugui	2014	1	14 months	42	Ciprofloxacin (500 mg, 12 hourly) and metronidazole (400 mg, 8 hourly) for 1 day	45	Ciprofloxacin (500 mg, 12 hourly) and metronidazole (400 mg, 8 hourly) for 5 days	Fever, bacteriuria	L	U	U	L	U	U	U
Aron a	2000	1	27 months	79	A single dose of ciprofloxacin (500 mg) and tinidazole (600 mg)	75	Placebo, twice a day for 3 days	Fever, urinary tract infection, prostatitis	L	U	U	L	U	U	U
Aron b	2000	1	27 months	79	A single dose of ciprofloxacin (500 mg) and tinidazole (600 mg)	77	Ciprofloxacin (500 mg) and tinidazole (600 mg), twice a day for 3 days	Fever, urinary tract infection, prostatitis	L	U	U	L	U	U	U
Bosquet	2006	1	4 months	86	Tobramicin (100 mg), one dose 30 minutes before biopsy and another one 8 hours afterwards and ciprofloxacin 500 mg, one dose 30 minutes before biopsy and afterwards they continue with the ciprofloxacin every 12 hours during 3 days	71	Tobramicin (100 mg), one dose 30 minutes before biopsy and another one 8 hours afterwards	Fever	U	U	U	U	U	U	U
Briffaux	2009	4	12 months	139	A single dose of ciprofloxacin (1000 mg)	149	Ciprofloxacin (1000 mg), for 3 days	Asymptomatic bacteriuria, prostatitis	L	U	U	L	U	U	U
Cam a	2008	1	6 years	130	A single dose of ciprofloxacin (500 mg)	131	Ciprofloxacin (500 mg), twice a day for 3 days	Fever, urinary tract infection	U	U	U	L	U	U	U
Cam b	2008	1	6 years	130	A single dose of ciprofloxacin (500 mg)	139	Ceftriaxone (1000 mg)	Fever, urinary tract infection	U	U	U	L	U	U	U
Chan	2012	1	20 months	188	An amoxicillin-clavulanate (1000 mg) + ciprofloxacin group (250 mg), one dose before and two doses after biopsy	179	An amoxicillin-clavulanate alone (1000 mg), one dose before and two doses after biopsy	Fever, chills, rigor	U	U	U	L	U	U	U
Cormio	2002	1	/	66	Ciprofloxacin (500 mg), twice a day for 7 days	72	Piperacillin/tazobactam (2250 mg), twice a day for 2 days	Fever, asymptonaticbacteriuria, unary tract infection	U	U	U	U	U	U	U
Heidari	2014	1	6 months	80	Ciprofloxacin (500 mg) and metronidazole (500 mg) at 2 hours before the biopsy	80	Ciprofloxacin (500 mg) and metronidazole (500 mg), from 3 days before the biopsy	Bacteriuria, urinary tract infection, fever	U	U	U	U	U	U	U
Kapoor	1998	5	14 months	227	Ciprofloxacin (500 mg)	230	Placebo	Bacteriuria, urinary tract infection	L	U	U	L	U	U	U
Lista	2014	1	15 months	312	Ciprofloxacin (500 mg), every 12 hours during 5 days	359	Fosfomycin-trometamol (3000 mg), 24 h before and 24 h after biopsy	Fever, bacteriuria	H	U	H	L	U	U	H
Roach	1991	1	/	28	Ciprofloxacin (500 mg), 12 hours before the schedule biopsy and a dose 12 hours after the first dose	27	Gentamicin (1.5 mg/kg)	Bacteremia, bacteriuria	U	U	U	U	U	U	U
Yang a	2001	1	30 months	64	A single dose of ciprofloxacin (500 mg) and metronidazole (400 mg)	62	A placebo, twice a day for 3 days	Fever, urinary tract infection	L	U	U	L	U	U	U
Yang b	2001	1	30 months	64	A single dose of ciprofloxacin (500 mg) and metronidazole (400 mg)	66	Ciprofloxacin (500 mg) and metronidazole (400 mg), twice a day for 3 days	Fever, urinary tract infection	L	U	U	L	U	U	U

Tobias-Machado a	2003	1	12 months	64	A single dose of ciprofloxacin (500 mg)	46	Ciprofloxacin (500 mg), for 3 days	Fever, acute urinary retention	U	U	U	U	U	U	U
Tobias-Machado b	2003	1	12 months	64	A single dose of ciprofloxacin (500 mg)	71	Chloramphenicol (500 mg), for 3 days	Fever, prostatitis, urinary tract infection, orchiepididymitis	U	U	U	U	U	U	U
Tobias-Machado c	2003	1	12 months	64	A single dose of ciprofloxacin (500 mg)	76	Norfloxacin (400 mg), for 3 days	Fever, prostatitis, urinary tract infection	U	U	U	U	U	U	U
Li Jiuzhi	2013	1	45 months	117	Ciprofloxacin (500 mg), one dose 60 minutes before the biopsy and twice a day for 3 days after the biopsy	105	Placebo	Fever, bacteremia, prostatitis, prostatic abscess, sepsis and shock	U	U	U	U	U	U	U

R: randomization sequence generation; B: blinded method; A: allocation concealment; C: complete outcome data addressed; F: free of selective reporting; O: free of other bias; L: low risk; H: high risk; U: unclear risk.

Figure 2. Comparison of the effect of ciprofloxacin and placebo on prevention of infectious complications. 95% CI, 95% confidence interval, RR risk ratio.

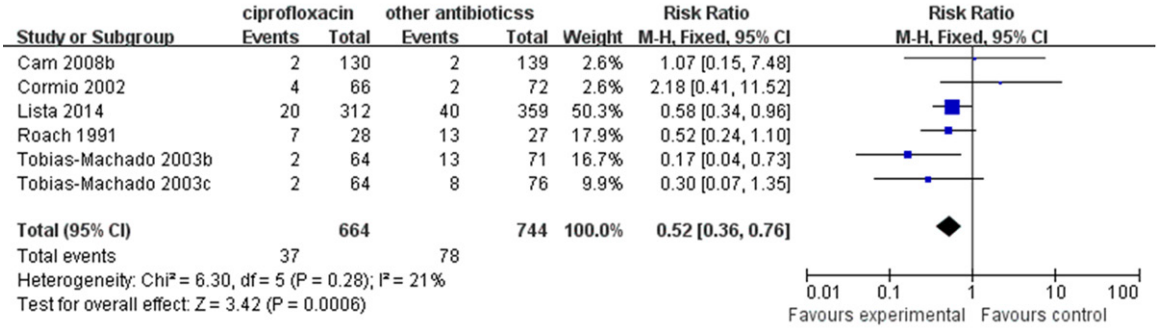

Figure 3. Comparison of the effect of ciprofloxacin and other antibiotics on prevention of infectious complications. 95% CI, 95% confidence interval, RR risk ratio.

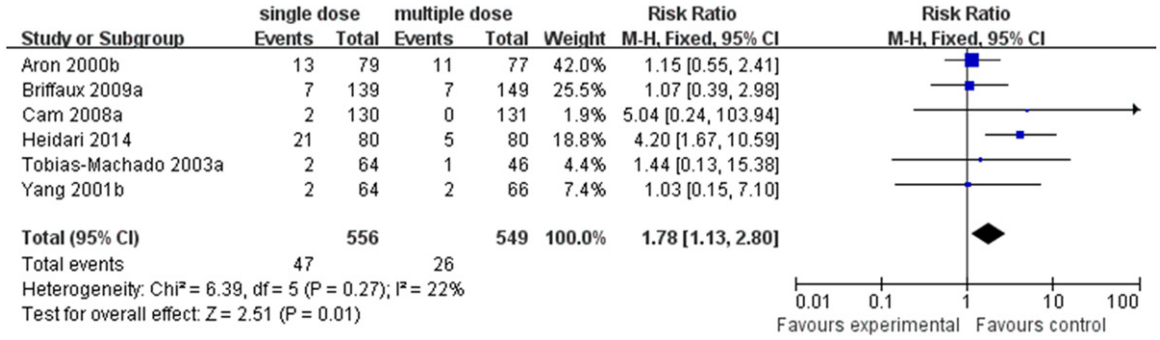

Figure 4. Comparison of the effect of single dose and multiple-dose regimes of ciprofloxacin on prevention of infectious complications. 95% CI, 95% confidence interval, RR risk ratio.

analysis was performed (RR 0.47; 95% CI 0.28, 0.80; p = 0.006).

Single dose versemultiple dose: Six trials [6, 10-12, 36, 39] involving 1105 participants, compared single dose of ciprofloxacin with multiple dose regime. It shows that single dose of ciprofloxacin was less effective than multiple dose regimes statistically with I^2 = 22% (RR 1.78; 95% CI 1.13, 2.80; p = 0.01) (**Figure 4**).

Risk of bias across studies

As was mentioned above, funnel plots were drawn. The funnel plots (**Figure 5**) did not show significant visual asymmetry.

Discussion

Complications, including hemorrhage and infection, occur frequently in patients undergoing transrectal prostate biopsy, reaching 79.3%

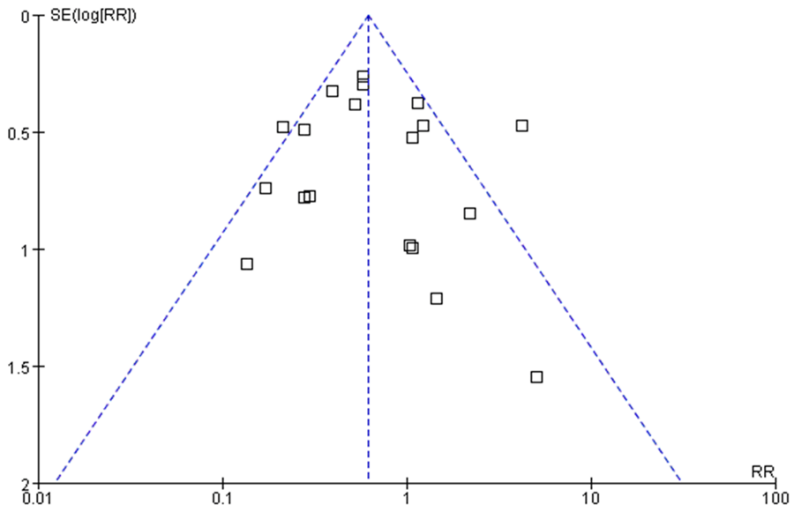

Figure 5. Funnel plot of trials included.

[41]. Bacteriuria, the incidence of which is 20%-65%, is the most frequent infectious complication following biopsy. In addition, fever, chill, prostatitis and unary tract infection, as infectious complications, have bad effects on patients' rehabilitation as well [42]. Uncontrolled infectious complications may result in septicemia, a serious complication which may lead to death [41, 42].

The administration of prophylactic antibiotics is able to reduce the incidence of infectious complications. Quinolinones, especially ciprofloxacin, are widely prophylactic administered in operations and were recommended by *Clinical practice guidelines for antimicrobial prophylaxis in surgery* [43] in preventing infection after transrectal prostate biopsy. Some studies showed that quinolinones administered prophylactically could reduce postoperative infectious complications after transrectal prostate biopsy to 1%-4% and even below [44-46]. Quinolinones' efficacy in prostate biopsy was also confirmed in several meta-analyses [47, 48]. However, towards each antibiotic belonging to quinolinones, such as ciprofloxacin, there is still little valid evidence of its efficacy and its proper regimes. The solid conclusion on ciprofloxacin prophylactic used in prostate biopsy is urgently needed.

This meta-analysis focused on the efficacy of ciprofloxacin in preventing infections for patients undergoing transrectal prostate biopsy. Overall, through pooling data from eligible RCTs, we found that ciprofloxacin had advantages over placebo and other prophylactic antibiotics. Ciprofloxacin's bacteria antibacterial activity is 2-4 times of norfloxacin and enoxacin and it has an antibacterial effect on *Enterobacteriaceae*, *Pseudomonas aeruginosa*, *Haemophilus influenzae*, *Neisseria gonorrhoeae*, *Streptococcus*, *Legionella*, *Staphylococcus aureus* [8], some of which were reported in infection after prostate biopsy [49]. So pharmacodynamics of ciprofloxacin determines its efficacy in prophylactic administered in transrectal prostate biopsy. In addition, ciprofloxacin is widely distributed in the body after absorption, and effective drug levels can be reached in prostate, lung and urogenital tract tissues. This property also contributes to ciprofloxacin's efficacy in prostate biopsy.

The results of the meta-analysis also showed that single dose of ciprofloxacin was less effective than multiple doses in preventing infectious complications. The conclusion may result from the half-time of ciprofloxacin. The half-time of ciprofloxacin (3.3-4.9 h) is short, compared with levofloxacin (5.1-7.1 h) and pefloxacin (10-12 h). One study also showed that infectious complications such as chill and fever often occur 5-16 hours after the biopsy and duration of fever and prostatitis reaches 4.8 ±2.6 days, 4.0±1.0 days respectively [49]. So a single dose of ciprofloxacin prophylactic administered in transrectal prostate biopsy may not prevent infectious complications as effectively as multiple-dose regimes.

However, a study showed that quinolinones administered recently may act as one of risk factors of acute infection after prostate biopsy [50]. And another study showed that 90 percentages of patients with infectious complications from transrectal prostate biopsy were resistant to quinolinones. This may result from the abuse of antibiotics, which lead to the high prevalence of antibiotic-resistant strains of *Enterobacteriaceae* [51]. So in order to reduce

the side effect of quinolinones in prostate biopsy, it is imperative for us to research on the efficacy of each kind of quinolinones, such as ciprofloxacin, and optimize the regimes of quinolinones administered.

In addition, some studies also demonstrated the clinical value of targeted antimicrobial method in prevention of postoperative infections in patients undergoing transrectal prostate biopsy [35, 52]. Due to the abuse of antibiotics, drug-resistant pathogenic bacteria become increasing frequent and formidable [52]. Targeted antimicrobial prophylaxis, guiding the administration of antibiotics according to anal swab culture, was associated with a notable decrease in the incidence of infectious complications after transrectal prostate biopsy and should be further studied for its advantages.

To our knowledge, this is the first meta-analysis assessing a certain antibiotic administered for the prevention of postoperative infection in transrectal prostate biopsy. We examined 14 articles, using infectious complications including fever, unary tract infection, prostatitis and so on as outcomes and focused on comparison of other agents and different regimes. We used comprehensive methods to make the results solid including sensitivity analysis and the results were stable and reliable.

One weakness of this meta-analysis was that the number of trials included was limited. For ciprofloxacin verse placebo, only four trials were included. In the other two comparisons, six trials were included respectively. The limited numbers of trials may result in bias of results and more trials on the efficacy of ciprofloxacin should be conducted further.

In conclusion, the meta-analysis shows that the prophylactic use of ciprofloxacin in transrectal prostate biopsy has significant advantages over placebo and other antibiotics. And multiple-dose regime of ciprofloxacin shows more effective in the prevention of infectious complications of prostate biopsy than single dose. In addition, drug-resistant resulted from abuse of quinolinonesand targeted antimicrobial prophylaxis should be researched further and considered by perioperative medical staff. It is of great importance to optimize the prophylactic use of antibiotics in transrectal prostate biopsy according to more RCTs and provide guidelines for the administration of antibiotics.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Xiaodi Yan, Department of Anesthesiology, Changzheng Hospital, Second Military Medical University, No 415, Feng Yang Road, Shanghai 200003, China. Tel: 86-1391781-2020; Fax: 86-02163520020; E-mail: yanxiaodi 0721@126.com

References

[1] Crawford ED, Haynes AJ, Story MW and Borden TA. Prevention of urinary tract infection and sepsis following transrectal prostatic biopsy. J Urol 1982; 127: 449-451.

[2] Davis M, Sofer M, Kim SS and Soloway MS. The procedure of transrectal ultrasound guided biopsy of the prostate: a survey of patient preparation and biopsy technique. J Urol 2002; 167: 566-570.

[3] Cormio L, Berardi B, Callea A, Fiorentino N, Sblendorio D, Zizzi V and Traficante A. Antimicrobial prophylaxis for transrectal prostatic biopsy: a prospective study of ciprofloxacin vs piperacillin/tazobactam. Bju Int 2002; 90: 700-702.

[4] Peters HJ and Breitling P. Antibiotic prophylaxis in transrectal prostate biopsy. Short-term vs. long-term therapy. Urologe A 2003; 42: 91-94.

[5] Dimick JB, Chen SL, Taheri PA, Henderson WG, Khuri SF and Campbell DJ. Hospital costs associated with surgical complications: a report from the private-sector National Surgical Quality Improvement Program. J Am Coll Surg 2004; 199: 531-537.

[6] Aron M, Rajeev TP and Gupta NP. Antibiotic prophylaxis for transrectal needle biopsy of the prostate: a randomized controlled study. Bju Int 2000; 85: 682-685.

[7] Kapoor DA, Klimberg IW, Malek GH, Wegenke JD, Cox CE, Patterson AL, Graham E, Echols RM, Whalen E and Kowalsky SF. Single-dose oral ciprofloxacin versus placebo for prophylaxis during transrectal prostate biopsy. Urology 1998; 52: 552-558.

[8] Koestner JA. Ciprofloxacin: a new fluoroquinolone. Am J Med Sci 1989; 297: 128-131.

[9] Ciprofloxacin Hydrochloride. The American Society of Health-System Pharmacists., 2015.

[10] Tobias-Machado M, Corrêa TD, De Barros EL and Wroclawski ER. Antibiotic prophylaxis in prostate biopsy. A comparative randomized clinical assay between ciprofloxacin, norfloxa-

cin and chloramphenicol. International Braz J Urol 2003; 29: 313-319.
[11] Heidari BZ, Shahrokh H, Salimi H, Safari H, Tabatabai M and Saedi D. Single-dose versus multiple-dose ciprofloxacin plus metronidazole prophylaxis in transrectal ultrasound-guided biopsy of the prostate: a randomized controlled trial. Acta Med Iran 2014; 52: 664-670.
[12] Briffaux R, Coloby P, Bruyere F, Ouaki F, Pires C, Dore B and Irani J. One preoperative dose randomized against 3-day antibiotic prophylaxis for transrectal ultrasonography-guided prostate biopsy. Bju Int 2009; 103: 1069-1073, 1073.
[13] Higgins JP GS. Cochrane Handbook for Systematic Reviews of Interventions, 2008.
[14] Herranz AF, Rodriguez FE, Diez CJ, Lledo GE, Verdu TF, Gonzalez CF and Subira CC. Morbidity of and tolerance to ultrasonography-guided transrectal biopsy of the prostate. Actas Urol Esp 1996; 20: 858-866.
[15] Sabbagh R, McCormack M, Peloquin F, Faucher R, Perreault JP, Perrotte P, Karakiewicz PI and Saad F. A prospective randomized trial of 1-day versus 3-day antibiotic prophylaxis for transrectal ultrasound guided prostate biopsy. Can J Urol 2004; 11: 2216-2219.
[16] Tekdogan Ü, Tuncel A, Eroglu M, Ünsal A, Atan A and Balbay MD. The efficiency of prophylactic antibiotic treatment in patients without risk factor who underwent transrectal. Turk Uroloji Dergisi 2006; 32: 261-267.
[17] Gou X and He ZM. The value of antibiotics in transrectal prostate biopsy. Chinese Journal of Andrology 2001; 15: 132-133.
[18] Briffaux R, Merlet B, Normand G, Coloby P, Leremboure H, Bruyere F, Pires C, Ouaki F, Dore B and Irani J. Short or long schemes of antibiotic prophylaxis for prostate biopsy. A multicentre prospective randomised study. Prog Urol 2009; 19: 39-46.
[19] Xu CL, Li ZR, Yang LP, Deng JH, Chen QH, You XY and Chen XQ. Clinical Observation of Single-dose Oral Ciprofloxacin and Metronidazole for Preventing Infections after Transrectal Prostate Biopsy. J Clin Res 2008; 25: 2138-2140.
[20] Yang LP, Hu JB, Wei HA, Wang LS and Zhong H. Clinical significance of antibiotic prophylaxis for transrectal prostate biopsy. Chin J Surg 2001; 39: 940-942.
[21] Rui WB, Zhang CY, Zhu Y, Wu YX, Liu DY, Zhang ZB, Zhang XY and Yi F. Evaluation of antibiotic prophylaxis in transperineal prostate biopsy. Chinese Journal of Andrology 2006; 20: 39-40.
[22] Wei RJ, Jia N, Yang WZ, Zhou HY, Zhao CL, Zhang YQ and Ma T. The administration of antibiotics in transperineal prostate biopsy. Acad J PLA Postgrad Med Sch 2008; 29: 385.
[23] Kehinde EO, Al-Maghrebi M, Sheikh M and Anim JT. Combined ciprofloxacin and amikacin prophylaxis in the prevention of septicemia after transrectal ultrasound guided biopsy of the prostate. J Urol 2013; 189: 911-915.
[24] Li YF, Zhang Y, Chen J, H YX and Zhang YP. Comparison of efficacy of three methods on prevention of infection after transrectal prostate biopsy. Journal of Nursing Science 2015; 30: 40-41.
[25] Schaeffer AJ, Wu SC, Tennenberg AM and Kahn JB. Treatment of chronic bacterial prostatitis with levofloxacin and ciprofloxacin lowers serum prostate specific antigen. J Urology 2005; 174: 161-164.
[26] Han JW. Seventy-three cases of chronic prostatitis treated by drug injection through transperineal prostate biopsy. Shanxi Med J 2011; 40: 586-587.
[27] Liao JX and Liao DY. Drug injection treatment of chronic bacterial prostatitis through transperineal prostate biopsy. Am J Chin Clin Med 2005; 7: 262-263.
[28] Bateni ZH, Shahrokh H and Khosropanah S. Randomized clinical trial of single versus multiple doses antimicrobial prophylaxis in transrectal ultrasound guided biopsy of the prostate. J Urology 2012; 187: e830-e831.
[29] Kuo T and Chong T. ABETRUS: Randomized controlled trial to investigate the use of antibiotics before transrectal ultrasound (TRUS) guided biopsy of the prostate and effects on PSA. Urology 2011; 78: S335.
[30] Eggener SE, Large MC, Gerber GS, Pettus J, Yossepowitch O, Smith ND, Kundu S, Kunnavakkam R, Zorn K and Raman JD. Empiric antibiotics for an elevated prostate-specific antigen (PSA) level: a randomised, prospective, controlled multi-institutional trial. Bju Int 2013; 112: 925-929.
[31] Erol H, Beder N, Caliskan T, Dundar M, Unsal A and Culhaci N. Can the effect of antibiotherapy and anti-inflammatory therapy on serum PSA levels discriminate between benign and malign prostatic pathologies? Urol Int 2006; 76: 20-26.
[32] Schaeffer AJ, Montorsi F, Scattoni V, Perroncel R, Song J, Haverstock DC and Pertel PE. Comparison of a 3-day with a 1-day regimen of an extended-release formulation of ciprofloxacin as antimicrobial prophylaxis for patients undergoing transrectal needle biopsy of the prostate. Bju Int 2007; 100: 51-57.
[33] Stopiglia RM, Ferreira U, Silva MJ, Matheus WE, Denardi F and Reis LO. Prostate specific antigen decrease and prostate cancer diagnosis: antibiotic versus placebo prospective randomized clinical trial. J Urol 2010; 183: 940-944.

[34] Ünal D, Koç A, Karataş ÖF and ÇImentepe E. Ciprofloxacin versus levofloxacin in avoidance of prostate biopsy in patients with isolated PSA elevation: A prospective randomized study. Turkish Journal of Medical Sciences 2012; 42: 778-786.

[35] Li JZ, Sun L, Wang XY and Wen B. Antibiotic prophylaxis for transrectal prostate biopsy: the value of rectal swab culture and targeted antimicrobial treatment. J Mod Urol 2013; 18: 78-79.

[36] Yang L, Hu J, Wei H, Wang L and Zhong H. Clinical significance of antibiotic prophylaxis for transrectal prostate biopsy. Zhonghua Wai Ke Za Zhi 2001; 39: 940-942.

[37] Bosquet SM, Gimeno AV, Arlandis GS, Bonillo GM, Trassierra VM and Jimenez CJ. Comparative study between tobramicin and tobramicin plus ciprofloxacin in transrectal prostate biopsy prophylaxis. Actas Urol Esp 2006; 30: 866-870.

[38] Lista F, Redondo C, Meilan E, Garcia-Tello A, Ramon DFF and Angulo JC. Efficacy and safety of fosfomycin-trometamol in the prophylaxis for transrectal prostate biopsy. Prospective randomized comparison with ciprofloxacin. Actas Urol Esp 2014; 38: 391-396.

[39] Cam K, Kayikci A, Akman Y and Erol A. Prospective assessment of the efficacy of single dose versus traditional 3-day antimicrobial prophylaxis in 12-core transrectal prostate biopsy. Int J Urol 2008; 15: 997-1001.

[40] Roach MB, Figueroa TE, McBride D, George WJ and Neal DJ. Ciprofloxacin versus gentamicin in prophylaxis against bacteremia in transrectal prostate needle biopsy. Urology 1991; 38: 84-87.

[41] de Jesus CM, Correa LA and Padovani CR. Complications and risk factors in transrectal ultrasound-guided prostate biopsies. Sao Paulo Med J 2006; 124: 198-202.

[42] Clements R, Aideyan OU, Griffiths GJ and Peeling WB. Side effects and patient acceptability of transrectal biopsy of the prostate. Clin Radiol 1993; 47: 125-126.

[43] Bratzler DW, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, Bolon MK, Fish DN, Napolitano LM, Sawyer RG, Slain D, Steinberg JP and Weinstein RA. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm 2013; 70: 195-283.

[44] Shigehara K, Miyagi T, Nakashima T and Shimamura M. Acute bacterial prostatitis after transrectal prostate needle biopsy: clinical analysis. J Infect Chemother 2008; 14: 40-43.

[45] Yamamoto S, Ishitoya S, Segawa T, Kamoto T, Okumura K and Ogawa O. Antibiotic prophylaxis for transrectal prostate biopsy: a prospective randomized study of tosufloxacin versus levofloxacin. Int J Urol 2008; 15: 604-606.

[46] Aus G, Ahlgren G, Bergdahl S and Hugosson J. Infection after transrectal core biopsies of the prostate--risk factors and antibiotic prophylaxis. Br J Urol 1996; 77: 851-855.

[47] Yang MG, Zhao XK, Wu ZP, Xiao N, Lu C and Hou Y. [Meta-analysis of antibiotic prophylaxis for postoperative bacteriuria in patients undergoing transrectal prostatic biopsy]. Zhonghua Yi Xue Za Zhi 2009; 89: 254-259.

[48] Zani EL, Clark OA and Rodrigues NNJ. Antibiotic prophylaxis for transrectal prostate biopsy. Cochrane Database Syst Rev 2011: D6576.

[49] Li YM, Tang J, Fei X, Xu L, Zhang SX and Yang JC. Infectious complications and treatment in transrectal ultrasound-guided prostate biopsies. Chin J Med Imaging Technol 2009: 884-886.

[50] Liu K, Meng JS, Xu ZY, Fu GB and Zhuang HJ. The influence of quinolone administered recently on the infection after prostate biopsy. The Journal of Practical Medicine 2013; 29: 1659-1661.

[51] Li HY, Yang BY, Huang XJ, Liu WH, Liu Y and Gao M. Clinical studies transrectal ultrasound guided prostate biopsy diagnosis of infectious complications re-duced. J Contemp Urol Reprod Oncol 2015; 7: 85-87.

[52] Siriboon S, Tiengrim S, Taweemongkongsup T, Thamlikitkul V and Chayakulkeeree M. Prevalence of antibiotic resistance in fecal flora of patients undergoing transrectal ultrasound-guided prostate biopsy in Thailand. Urol Int 2012; 88: 187-193.