·实验论著·

非接触眼压计测量高眼压兔模型的准确性

杨 欣,单武强,毛治平

作者单位:(721000)中国陕西省宝鸡市人民医院眼科
作者简介:杨欣,男,硕士,主治医师,研究方向:白内障、青光眼、玻璃体视网膜疾病。
通讯作者:杨欣. yangtze68@tom. com
收稿日期:2010-08-27 修回日期:2010-10-18

Accuracy of intraocular pressure measured by noncontact tonometer in rabbit eyes in high intraocular pressure state

Xin Yang, Wu-Qiang Shan, Zhi-Ping Mao

Department of Ophthalmology, Baoji People's Hospital, Baoji 721000, Shaanxi Province, China
Correspondence to: Xin Yang . Department of Ophthalmology, Baoji People's Hospital, Baoji 721000, Shaanxi Province, China. yangtze68@tom. com
Received:2010-08-27 Accepted:2010-10-18

Abstract

• AIM: To investigate the accuracy of intraocular pressure (IOP) by noncontact tonometer (NCT), and the correlation between the actual IOP and the NCT value in New Zealand white rabbit eyes in high IOP state.

• METHODS: The actual IOP was regulated by the height of the saline column through a 22G intravenous catheter needle punctured into vitreous cavity in rabbit eyes, under general anesthesia. The actual IOP was measured with liquid pressure transducer through a 24G needle inserted into the anterior chamber. The NCT value were taken by NCT. The height of the saline column was adjusted, the actual IOP readings in the pressure transducer was varied from 15 to 45mmHg in steps of 5mmHg. At each pressure level the IOP was measured simultaneously with NCT. The NCT error (actual IOP minus NCT value) was calculated. Readings of the two techniques were compared with *t*-test. The relationship between the actual IOP and NCT value was analyzed with Pearson correlation, and liner regression analysis was performed in the two variables.

• RESULTS: NCT values were all obviously lower than actual ones, and the mean NCT error was 13. 65 ± 2. 25mmHg. The readings of two measurements were of statistically significant differences ($P < 0.01$). But there was also a significant correlation between two measurements ($r = 0.985$, $P < 0.01$), and there was a regression equation for actual IOP, $Y = 10.875 + 1.170X$ ($F = 2691.389$, $P < 0.01$), each 0. 855mmHg increase in actual IOP (Y) caused 1mmHg increase in NCT values (X).

• CONCLUSION: NCT value underestimate the actual IOP in rabbit eyes, NCT error increases as actual IOP increases. There is a significant correlation between two measurements. It is also necessary that the regression equation be used to calibrate NCT value to get a more accurate one. Measuring IOP with NCT is feasible in rabbit eyes in high IOP state.

• KEYWORDS: intraocular pressure; high intraocular pressure; pressure transducer; noncontact tonometer; rabbits

Yang X, Shan WQ, Mao ZP. Accuracy of intraocular pressure measured by noncontact tonometer in rabbit eyes in high intraocular pressure state. *Int J Ophthalmol (Guoji Yanke Zazhi)* 2010; 10 (11):2077-2079

摘要

目的:探讨非接触眼压计(NCT)测量高眼压兔模型的准确性。

方法:兔全身麻醉后前房、玻璃体腔穿刺,通过平衡盐水柱高低调控眼内压,前房插管显示实际眼压于 15. 00 ± 0. 50,20. 00 ± 0. 50,25. 00 ± 0. 50,30. 00 ± 0. 05,35. 00 ± 0. 50,40. 00 ± 0. 50,45. 00 ± 0. 50mmHg,同时测量相对应的 NCT 眼压。分析实际眼压与 NCT 眼压的差异及相关性,以实际眼压作为应变量进行回归分析。

结果:兔 NCT 眼压均低于实际眼压值,有显著性差异($P < 0.01$)。兔 NCT 眼压与实际眼压两者具有显著相关性(相关系数 $r = 0.985$, $P < 0.01$)。筛选回归方程 $Y = 10.875 + 1.170X$(方差分析 $F = 2691.389$, $P < 0.01$),式中 Y 为实际眼压,X 为 NCT 眼压。

结论:NCT 能够用于测量高眼压兔模型,实际眼压与 NCT 眼压之间有直线关系,可借助回归方程通过 NCT 眼压推断实际眼压,为兔青光眼模型眼压测量提供了实验支持。

关键词:眼压;高眼压;压力感受器;非接触眼压计;兔
DOI:10. 3969/j. issn. 1672-5123. 2010. 11. 011

杨欣,单武强,毛治平. 非接触眼压计测量高眼压兔模型的准确性. 国际眼科杂志 2010;10(11):2077-2079

0 引言

非接触眼压计(noncontact tonometer, NCT)用于测量兔眼压研究的报道较多。研究表明根据人眼设计的 NCT 测量值偏差较大,采用 NCT 测量的兔眼压需加以校正[1,2]。但上述研究为正常兔眼压,眼压低、眼压范围小,兔眼压范围 13. 97 ~ 35. 49(平均 22. 22 + 6. 40) mmHg[1]。Bar-Ilan 用气动式眼压计测得正常兔眼压为 19. 6 ± 2. 0mmHg ($n = 1957$)[3]。对于高眼压兔模型中,眼压往往较高如 45mmHg,这时的 NCT 测量值能否矫正兔实际眼压、NCT 测量是否可行尚缺乏资料。作为系列研究,我们的实验通过玻璃体腔穿刺调控兔眼压,研究 NCT 测量高眼压兔模

型的准确性,为 NCT 测量高眼压兔模型研究提供实验资料。

1 材料和方法

1.1 材料　选取健康成年新西兰白兔 12 只(兰州生物制品研究所提供,医动字 14-004 号),排除眼疾,雌雄兼用,3 ~ 4 月龄,体质量 2.0 ~ 2.8(2.2 ± 0.2)kg,均取右眼实验。TopconCT-60 非接触眼压计(Japan);玻璃体腔穿刺调控眼内压装置:22G-Y 型留置针穿刺入玻璃体,留置针通过两个三通管连接 10mL(粗调)、1mL(微调)注射器和向上安置的静脉输液器(上端开放于大气),管道内充满含 50IU/mL 肝素的平衡盐溶液(balanced salt solution, BSS);前房插管直接测压装置:24G-Y 型静脉留置针(苏州碧迪医疗器械有限公司)、BL-420 生物机能实验系统(成都泰盟公司)构成,管道内充满含 50IU/mL 肝素的 BSS;YZSF 型裂隙灯升降控制台;YZ6F 型检眼镜;台式血压计;兔盒、头位固定装置、开睑器、结膜镊、三通管、输液器、注射器等。

1.2 方法　30g/L 戊巴必妥(约 25 ~ 50mg/kg)耳缘 iv 麻醉后,兔盒、头位固定装置固定兔头及眼位。加 5g/L 地卡因表面麻醉后,行玻璃体腔穿刺插管调控眼压,前房插管测压装置精确显示实际眼压于 15.00 ± 0.50,20.00 ± 0.50,25.00 ± 0.50,30.00 ± 0.05,35.00 ± 0.50,40.00 ± 0.50,45.00 ± 0.50mmHg,同时测量对应的 NCT 眼压。取得实际眼压、NCT 眼压数据。玻璃体腔穿刺调控眼内压:22G 留置针在颞上方角膜缘后 3mm 处穿刺入玻璃体,留置针通过两个三通管连接 10mL(粗调)、1mL(微调)注射器和向上安置的静脉输液器(上端开放于大气),管道内充满 BSS,通过两个注射器前后推动调控静脉输液器液面高度,改变兔眼内压。测量插管实际眼压:直接测压装置以同一端口、压力传感器调零、定标完成,实验期间定时检测。颞上方角膜缘内 1mm 处,以 24G 静脉留置针头穿刺入前房,退出针芯,BL-420 系统即逐渐显示精确的实际眼压。测量 NCT 眼压:前房穿刺后,玻璃体腔穿刺调控眼压装置缓慢调控,防止压力剧烈波动,前房插管测压装置精确显示实际眼压于 15.00 ± 0.50,20.00 ± 0.50,25.00 ± 0.50,30.00 ± 0.05,35.00 ± 0.50,40.00 ± 0.50,45.00 ± 0.50mmHg 且稳定后,测量对应的 NCT 眼压。测 NCT 眼压 3 次或 3 次以上,选择眼压波动值≤3mmHg(0.4kPa)的 3 次眼压值,取平均值。

统计学分析:用 SPSS 11.5 软件包,实际眼压与 NCT 眼压的差异采用配对 t 检验,两者进行相关分析,取检验水准 $\alpha = 0.05$。

2 结果

2.1 实际眼压与 NCT 眼压的差异　显示所有 NCT 眼压、NCT 眼压均数都低于对应的实际眼压。NCT 眼压误差(实际眼压 - NCT 眼压)范围为 9 ~ 19mmHg、均数 ± 标准差为 13.7 ± 2.3mmHg(表 1)。采用配对 t 检验:实际眼压、NCT 眼压差异有统计学意义($t = -55.520$, $P < 0.01$)。

2.2 实际眼压与 NCT 眼压的相关　作散点图(图 1),提示兔实际眼压与 NCT 眼压呈直线趋势。相关分析:实际眼压与 NCT 眼压有显著相关关系(相关系数 $r = 0.985$, $P < 0.01$)。以实际眼压为应变量,以 NCT 眼压为自变量,作回归分析:$Y = 10.875 + 1.170X$(图 2),决定系数 r Square = 0.970,方差分析 $F = 2691.389$, $P < 0.01$,残差图考察理想(图 3,4),回归拟合可靠。

表 1　NCT 眼压及 NCT 眼压误差　　mmHg

实际眼压	NCT 眼压 $\bar{x} \pm s$	分布范围	NCT 眼压误差 $\bar{x} \pm s$	分布范围
15	4.1 ± 1.1	3 ~ 6	10.8 ± 1.0	9 ~ 12
20	8.3 ± 1.4	7 ~ 11	11.7 ± 1.5	9 ~ 13
25	11.6 ± 1.5	9 ~ 14	13.5 ± 1.5	11 ~ 16
30	16.0 ± 1.0	14 ~ 18	14.1 ± 1.0	12 ~ 16
35	20.7 ± 1.7	18 ~ 24	14.3 ± 1.7	11 ~ 17
40	25.5 ± 1.7	23 ~ 29	14.5 ± 1.6	11 ~ 17
45	28.3 ± 1.6	26 ~ 32	16.7 ± 1.5	13 ~ 19

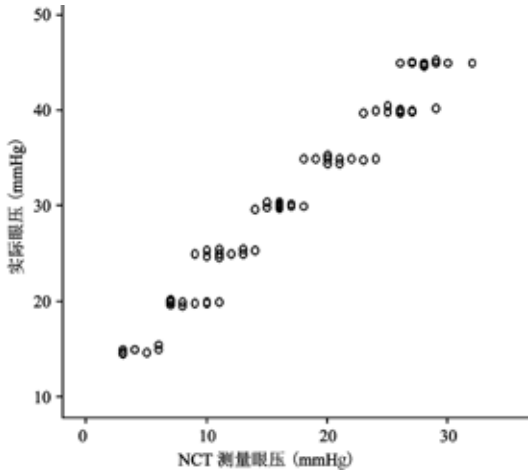

图 1　实际眼压与 NCT 眼压的散点图。

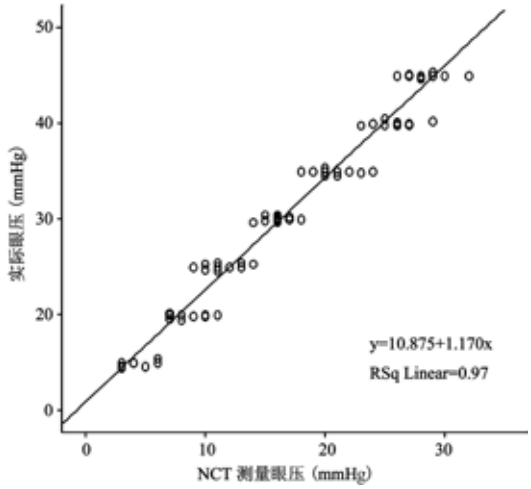

图 2　实际眼压与 NCT 眼压的回归曲线。

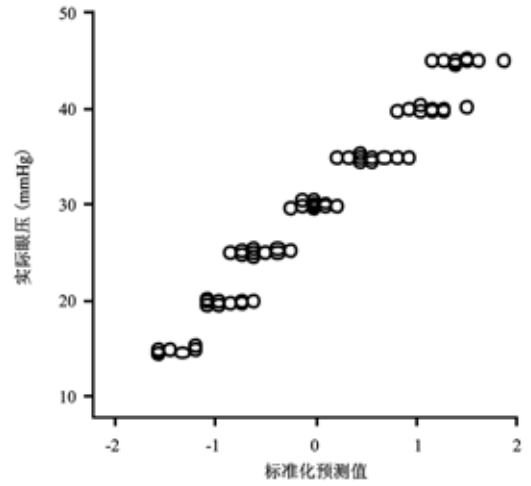

图 3　实际眼压与标准化预测值的散点图。

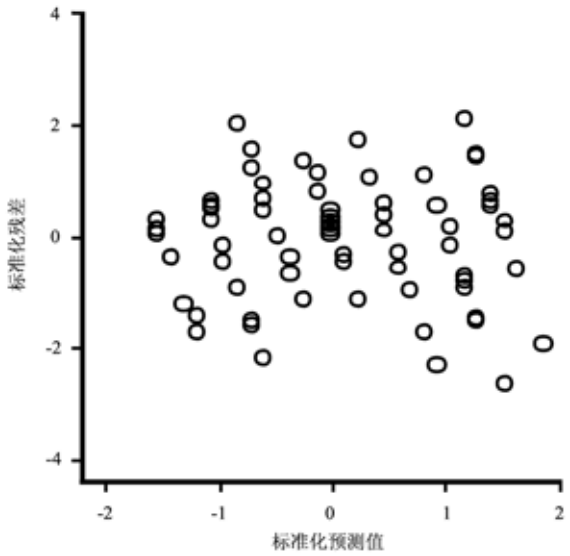

图4 标准化残差压与标准化预测值的散点图。

3 讨论

兔青光眼模型一般以造模后符合眼压≥22mmHg,且持续超过1wk 为标准[4],兔眼压升高较长时间后角膜组织学、巩膜硬度等情况会有改变。我们的研究中的高眼压兔模型,是通过玻璃体腔穿刺连通平衡盐水柱在短时间内人为改变眼内压,不完全符合兔青光眼模型的状态,只是初步研究手段。我们的研究中玻璃体腔穿刺调控眼压装置缓慢调控,防止压力剧烈波动,在原来眼压基础上逐渐上升直至45mmHg(如果高于15mmHg 时先向下、再逐渐向上调控)。在预实验中发现有些兔在深度麻醉下实际眼压可降至12mmHg、甚至10mmHg 以下,测 NCT 读数均为1mmHg。因此,当 NCT 测量值为1mmHg 时,准确评估实际眼压较为困难。全麻深度以能进行实验即可,尽可能减少麻醉对眼压的影响。个别兔角膜在眼内压50mmHg 时出现角膜水肿,不排除眼压升高过快引起,可能不接近兔青光眼模型的状态,故只取45mmHg 以下数据研究。有待于采用造模后的兔青光眼模型、较大样本作进一步研究。

研究显示兔 NCT 眼压明显低于实际眼压,实际眼压、NCT 眼压差异有统计学意义(t = -55.520, P < 0.01)。NCT 眼压误差最小为9mmHg,最大为19mmHg,均数±标准差为13.7±2.3mmHg。采用 NCT 测量时所得 NCT 眼压值误差较大。同时,兔实际眼压与 NCT 眼压呈高度相关(相关系数 r = 0.981, P < 0.01),回归方程为 Y = 10.875 + 1.170X,式中 Y 为实际眼压,X 为 NCT 眼压。决定系数 r Square = 0.970,方差分析 F = 2691.389, P < 0.01。根据斜率 b = 1.170,NCT 眼压值每增加0.855mmHg 其实际眼压值增加1mmHg。表明 NCT 眼压越高,实际眼压越高,且实际眼压升高的幅度大于 NCT 眼压。即兔实际眼压越低,NCT 眼压与实际眼压误差越小;实际眼压越高,NCT 眼压与实际眼压误差越大。Tuunanen、Stahl 发现气动眼压计、Tono-Pen 测量值较实际眼压整体偏低,测量误差随实际眼压升高而增大。Foster 等[5]通过对中国人眼直接测量眼压,得出 Perkin's ,Tono-Pen 测量值偏低,得出真实眼压 = 1.08 × 压平眼压 + 5.5mmHg 的校正公式。我们的研究关于 NCT 测量高眼压兔模型的结论与此相似。

综上所述,兔高眼压状态下 NCT 眼压读数显著低于实际眼压、误差较大。实际眼压与 NCT 眼压有显著相关,可采用回归方程通过校正 NCT 眼压数据推断实际眼压。为 NCT 用于高眼压兔模型的眼压研究提供了实验支持。有待于采用造模后兔青光眼模型,在更接近青光眼疾病状态下进一步研究。

参考文献

1 杨欣,张文芳,鲁建华. 非接触眼压计测量兔眼压的准确性和可行性. 国际眼科杂志 2007;7(6):1571-1573

2 Gupta SK, Saxena R, Agarwal R, *et al*. Estimation of intraocular pressure in rabbits using noncontact tonometer: a comparative evaluation with Schiotz tonometer. *Methods Find Exp Clin Pharmacol* 2007;29(6):405-409

3 Bar-Ilan A. Diurnal and seasonal variations in intraocular pressure in the rabbit. *Exp Eye Res* 1984;39(2):175-181

4 徐岩,陈祖基,宋洁贞. 复方卡波姆诱发的兔高眼压模型与其它兔高眼压模型的比较研究. 中华眼科杂志 2002; 38(3):172-175

5 Foster PJ, Wong JS, Wong E, *et al*. Accuracy of clinical estimates of intraocular pressure in Chinese eyes. *Ophthalmology* 2000;107(10):1816-1821