The effects of Vitamin C on Tooth Growth Cells

Rudy Veenhoff

Overview

In this article we will look at the effects of vitamin C on tooth growth in guinea pigs. Different delivery methods will be tested as well as different dose levels. The data comes from the ToothGrowth data set in R.

Loading the data and some basic exploratory analysis

We will take a look at the ToothGrowth data set do some basic exploratory analysis.

```
library(datasets)
str(ToothGrowth)
```

```
## 'data.frame':    60 obs. of  3 variables:
##  $ len : num  4.2 11.5 7.3 5.8 6.4 10 11.2 11.2 5.2 7 ...
##  $ supp: Factor w/ 2 levels "OJ","VC": 2 2 2 2 2 2 2 2 2 2 ...
##  $ dose: num  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 ...
```

A description of the data set as given by its documentation page is insightful: "The response is the length of odontoblasts (cells responsible for tooth growth) in 60 guinea pigs. Each animal received one of three dose levels of vitamin C (0.5, 1, and 2 mg/day) by one of two delivery methods, orange juice or ascorbic acid (a form of vitamin C and coded as VC)."

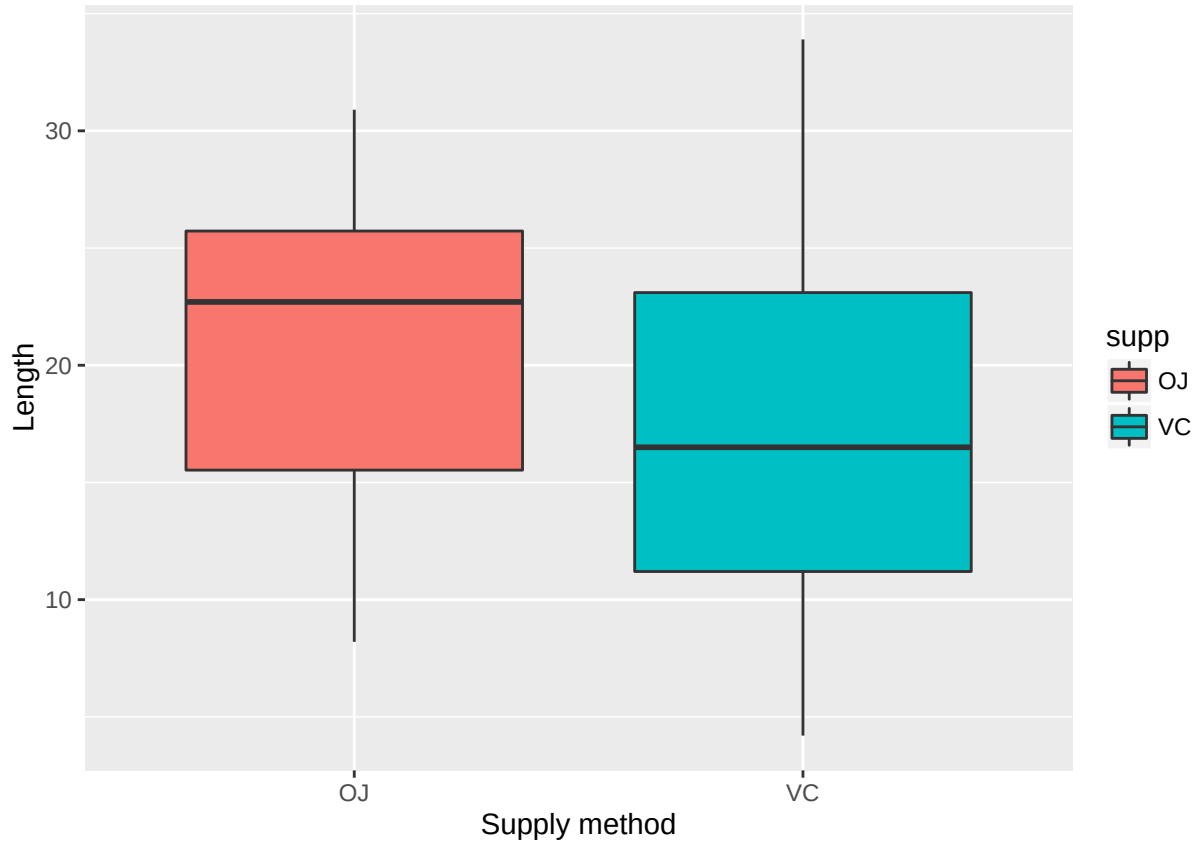
This suggests testing whether dose level or delivery method has any effect on the length of odontoblasts cells. We start by comparing the five number summaries for Orange Juice and Vitamin C.

```
OJ<-summary(ToothGrowth$len[ToothGrowth$supp=="OJ"])
VC<-summary(ToothGrowth$len[ToothGrowth$supp=="VC"])
rbind(OJ,VC)
```

```
##    Min. 1st Qu. Median  Mean 3rd Qu. Max.
## OJ  8.2   15.52   22.7 20.66   25.72 30.9
## VC  4.2   11.20   16.5 16.96   23.10 33.9
```

Or, as viewed in a simple plot:

```
library(ggplot2)
ggplot(ToothGrowth,aes(x=supp,y=len,fill=supp)) +
  geom_boxplot() +
  labs(x="Supply method", y="Length")
```



It looks like orange juice has a greater effect on the length of tooth growth cells than vitamin C. Based on this we will use a one-sided test.

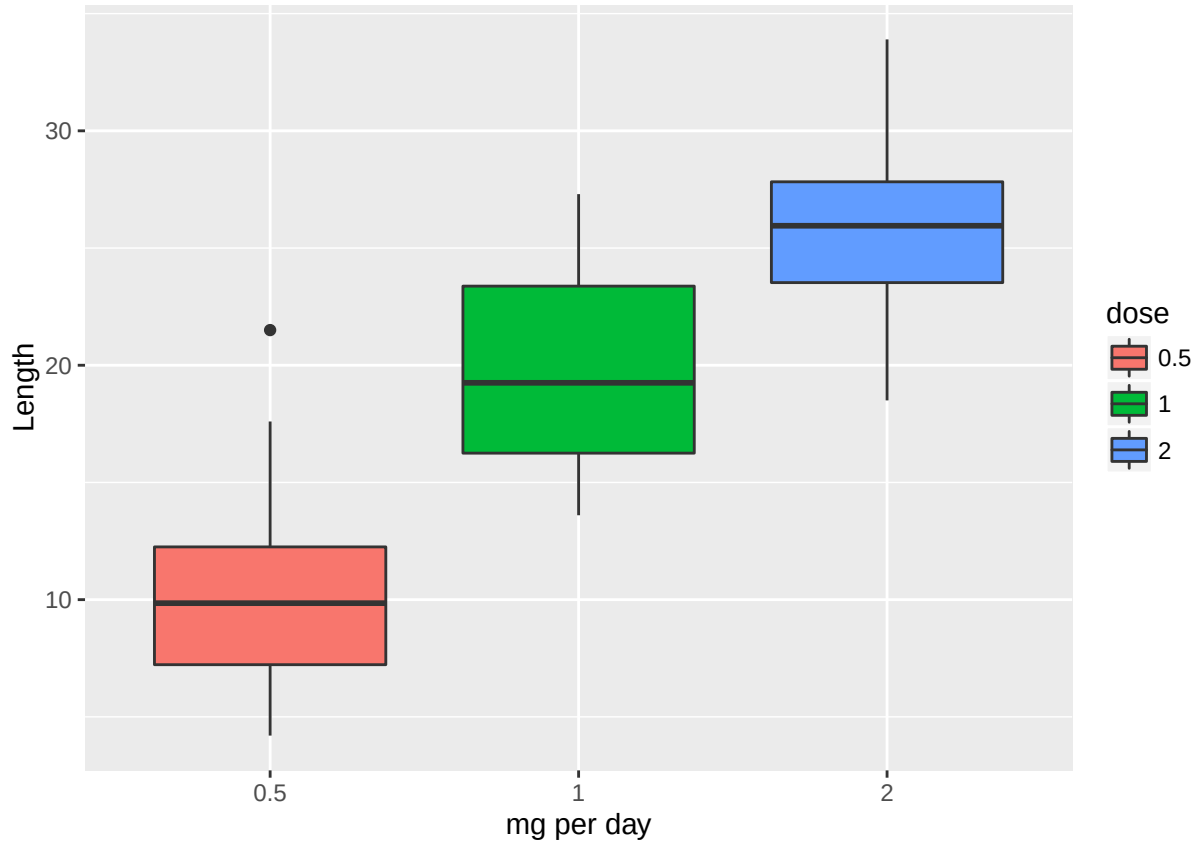
Now we will at the five number summaries for dose levels.

```
half <- summary(ToothGrowth$len[ToothGrowth$dos==.5])
one <- summary(ToothGrowth$len[ToothGrowth$dos==1])
two <-summary(ToothGrowth$len[ToothGrowth$dos==2])
summ <- rbind(half,one,two)
rownames(summ) <-c(".5 mg/day","1 mg/day","2 mg/day")
summ
```

```
##           Min. 1st Qu. Median  Mean 3rd Qu. Max.
## .5 mg/day  4.2   7.225   9.85 10.60   12.25 21.5
## 1 mg/day  13.6  16.250  19.25 19.74   23.38 27.3
## 2 mg/day  18.5  23.520  25.95 26.10   27.83 33.9
```

and the corresponding boxplot:

```
ToothGrowth$dose <- as.factor(ToothGrowth$dose)
ggplot(ToothGrowth,aes(x=dose,y=len,fill=dose))+
  geom_boxplot()+
  labs(x="mg per day", y="Length")
```



This very clearly suggests that higher dose levels means longer tooth growth cells. Again, we will use a one-sided test.

Testing

We shall test if delivery method has a significant effect on tooth growth using a one-sided t-test. We assume that our guinea pigs aren't use more than once for testing and that all guinea pigs come from the same population and hence have we can assume equal variance.

```
t.test(len ~ supp, paired=F, var.equal=T, data=ToothGrowth, alternative="greater")$p.value
```

```
## [1] 0.03019669
```

Now we perform the t-tests for dose levels.

```
ToothGrowth051 <- subset(ToothGrowth,dose %in% c(0.5,1))
t.test(len ~ dose, paired=F, var.equal=T, data=ToothGrowth051, alternative="less")$p.value
```

```
## [1] 6.331485e-08
```

```
ToothGrowth12 <- subset(ToothGrowth,dose %in% c(1,2))
t.test(len ~ dose, paired=F, var.equal=T, data=ToothGrowth12, alternative="less")$p.value
```

```
## [1] 9.054143e-06
```

Conclusions

Under the assumptions of equal variance and unpairedness of the data we conclude that giving orange juice as oppposed to ascorbic acid has a positive result on the length of tooth growth cells in guinea pigs with a p-value of 0.03.

Under the same assumptions, we've tested whether dose levels have any effect on the length of tooth grow cells. The t-tests are giving very low p-values. We conclude that for dose levels of 0.5 mg/day, 1 mg/day and 2 mg/day: a higher dose means longer tooth growth cells.