T_{pq} transforms the pair (a, b) such that $a \leftarrow bq + aq + ap$ and $b \leftarrow bp + aq$.
After two transformations we get:

$$\begin{aligned}
a &\leftarrow (bp + aq)q + (bq + aq + ap)q + (bq + aq + ap)p \\
&= pqb + q^2a + q^2b + q^2a + pqa + pqb + pqa + p^2a \\
&= p^2a + 2pqa + 2pqb + 2q^2a + q^2b \\
&= a(p^2 + 2pq + 2q^2) + b(2pq + q^2) \\
b &\leftarrow (bp + aq)p + (bq + aq + ap)q \\
&= p^2b + pqa + q^2b + q^2a + pqa \\
&= p^2b + 2pqa + q^2a + q^2b \\
&= b(p^2 + q^2) + a(2pq + q^2).
\end{aligned}$$

From above, $a \leftarrow a(p^2 + 2pq + 2q^2) + b(2pq + q^2)$

$$= b(2pq + q^2) + a(2pq + q^2) + a(p^2 + q^2).$$

Therefore, if we let $p' = p^2 + q^2$ and $q' = 2pq + q^2$, then we can represent applying T_{pq} twice with the single transformation $T_{p'q'}$.