Cost Comparison Between Defocus Spectacle Lens and Compound Atropine in Myopia Treatment in the Portuguese Setting

Comparação do Custo de Lentes de Desfocagem e Atropina Manipulada no Tratamento da Miopia no Contexto Português

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ABSTRACT

INTRODUCTION: The rising prevalence of myopia poses a substantial global concern. Low concentration atropine and defocus spectacle lens (DSL) are the most widely used myopia prevention treatment in Portugal. Atropine drops must be compounded in pharmacies, because there is still no commercial low concentration atropine approved in Portugal. There are no studies with enough evidence to prefer one treatment over the other, so cost might be a decisive factor.

Our purpose was to compare the costs between DSL and compound atropine for myopia progression prevention in Portugal.

METHODS: We collected data on compound atropine from different pharmacies in Portugal, monofocal (MF) lenses prices from the four most common brands in Portugal and DSL price from brand representatives. Cost estimates were done per year of four consecutive years of myopia prevention treatment, considering different scenarios according to the need of spectacle lens exchange. We compared costs of low dose compound atropine plus MF lens versus DSL in the different scenarios.

RESULTS: Atropine treatment proved more cost-effective than DSL treatment only when there was a requirement for lens exchange every 6 months or less (609.25€ for atropine *versus* 780.00€ for DSL per year of treatment). When myopia progression prevention is more effective and the need of lens exchange is equal or greater than 12 months, DSL treatment showed to be less expensive than mean values of atropine treatment plus MF lens (390.00€ for DSL *vs* 464.59€ for atropine, per year of treatment).

CONCLUSION: DSL take a cost advantage in prevention of myopia progression, in situations when there is a need of lens exchange within once a year or less frequently. However, atropine plus MF lenses might be a less expensive in cases whenever there is a need of lens exchange every 6 months or more frequently. It is essential to conduct further studies focusing on the cost-effectiveness of different treatment options for preventing myopia progression.

KEYWORDS: Atropine/therapeutic use; Cost-Effectiveness Analysis; Eyeglasses; Lenses, Intraocular; Myopia/therapy.

RESUMO

INTRODUÇÃO: A crescente prevalência da miopia é uma preocupação global cada vez mais acentuada. A atropina em baixa concentração e as lentes de desfocagem são as opções de tratamento mais utilizadas em Portugal. Os colírios de atropina têm de ser manipulados nas farmácias, porque não existe atropina em baixa concentração aprovada para comercialização em Portugal. Ainda não existem estudos suficientes para determinar uma preferência clara entre os dois tratamentos, o que torna o custo do tratamento um fator importante na escolha tanto dos médicos quanto dos pacientes.

O nosso objetivo foi comparar o custo das lentes de desfocagem com a atropina manipulada na prevenção da progressão da miopia em Portugal.

MÉTODOS: Foram recolhidos os preços de atropina manipulada de diferentes farmácias em Portugal, de lentes monofocais de quatro marcas comuns e de lentes de desfocagem, através de representantes das marcas. As estimativas de custos foram calculadas por ano de tratamento, para quatro anos consecutivos de tratamento, tendo em conta diferentes tempos entre mudança de lentes. Foram comparados os custos de atropina manipulada e lentes monofocais com lentes de desfocagem em diferentes cenários.

RESULTADOS: A opção atropina manipulada e lentes monofocais, tendo em conta os valores médios, é favorável em termos de custo apenas se a mudança de lentes ocorrer a cada seis meses ou com uma frequência maior (609,25€ para a atropina *versus* 780,00€ para as lentes de desfocagem, por ano). Quando a prevenção da progressão da miopia é eficaz, e a troca de lentes ocorrer a cada 12 meses ou com menos frequência, as lentes de desfocagem demonstraram ser menos dispendiosas do que a atropina manipulada e lentes monofocais (390,00€ para as lentes de desfocagem *versus* 464,59€ para a atropina, por ano).

CONCLUSÃO: As lentes de desfocagem demonstraram ser vantajosas em termos de custo na prevenção da progressão da miopia em situações em que a substituição das lentes ocorre uma vez por ano ou com uma frequência menor. No entanto, em situações em que a substituição das lentes ocorre a cada seis meses ou com uma frequência maior, a opção de utilizar atropina manipulada e lentes monofocais pode ser mais económica. É crucial realizar estudos de custo-efetividade para avaliar as diferentes opções de prevenção da progressão da miopia.

PALAVRAS-CHAVE: Análise de Custo-Efetividade; Atropina/uso terapêutico; Lentes Intraoculares; Miopia/tratamento; Óculos.

INTRODUCTION

Myopia is growing pandemic in the world and multiple efforts are being made in order to achieve reliable methods on preventing it and slowing its progression.[1,2]

Atropine drops have been used to slow myopia progression, with recent and robust studies favouring lower atropine concentrations, namely 0.01%-0.1%.[3] Defocus spectacle lenses (DSL) are also showing up with promising results with recent randomised clinical trials showing statistically significant slowing of myopia progression and axial elongation in myopic children wearing DSL comparing to single vision spectacle lenses.[4,5] Outcomes were confirmed after 3 and 6 years of follow-up.[6,7]

The World Society of Paediatric Ophthalmology and Strabismus recently published a Consensus in February 2023 on the Interventions to Slow the Progression of Myopia.[8] In this document, both DSL and low concentration atropine are considered effective interventions, but there are no considerations on which treatment to favour, due to the lack of comparative studies.

So far there are only two papers published in 2023 comparing these different methods for myopia progression.[9] In one study, Nucci *et al* compared 0.01% atropine eyedrops, defocused incorporated multiple segments lens (DIMS) (Hoya® MiyoSmart®) spectacles, combined atropine+DIMS or single vision spectacle lenses (control group). In pairwise comparisons at 6 and 12 months the atropine+DIMS group

had significantly reduced spherical equivalent progression compared with the DIMS only and Atropine only groups (p<0.001). However, they found no statistically significant difference between the four groups in terms of AL progression. Guimarães S *et al* compared 0.01% atropine eyedrops and DIMS spectacle lenses for slowing the progression of myopia. Their study favoured DIMS lenses in terms of AL elongation in a short-term follow-up, but there was no difference in terms of spherical equivalent between groups.[10] This evidence is not yet sufficient to warrant a formal recommendation regarding which method should be employed.

In Portugal, both low concentration atropine (0.01%-0.1%) and DSL are being used by paediatric ophthalmologists to slow myopia progression in children. Atropine drops must be compounded in pharmacies, because there is still no commercial low concentration atropine approved in Portugal. There are two types of DSL in the Portuguese market with published 2-years effective results: the defocused incorporated multiple segments (DIMS) lens (Hoya® MiYOSMART®) and the spectacle lenses with highly aspherical lenslets (HAL) (Essilor®, Stellest®).[4,5]

Both atropine and DSL have advantages and disadvantages. Compound low concentration atropine prices depend on the pharmacies. One of the practical drawbacks is that it requires the cooperation and compliance of both parents and children. Additionally, parents must visit a pharmacy every 15 days to purchase fresh pharmacy-compounding drops. On the other hand, DSL might imply a bigger financial initial investment. As there is no evidence to prefer one treatment over the other, ophthalmologists tend to choose the method that best suits their patient needs, both in terms of comfort, compliance, accessibility and economic factors.

Fricke TR *et al* performed a study in order to establish a method to estimate the effect of anti-myopia management options on lifetime cost of myopia.[11] They concluded that the lowest lifetime cost options in Australia were anti-myopia spectacles and in China low-dose atropine. They also found that active myopia management (AMM) options generally involved higher costs in childhood compared to traditional corrective methods (meaning single-vision correction), although traditional methods' costs were more expensive later in life than AMM with higher myopia.

So far, to our knowledge, there are no studies comparing DSL and compound atropine prices in Portugal. This information is crucial so eyecare practitioners can discuss with parents when the need to choose a treatment option comes.

The aim of this study is to compare the costs between DSL and compound atropine for myopia progression prevention in Portugal. When clinical evidence is not enough to choose between treatments, cost might be an insightful information for an informed choice.

METHODS

DATA COLLECTION:

We collected data on compound atropine 0.01%, 0.025% and 0.05% prices in 8 pharmacies located in different cities across Portugal, spanning from the north to the south of the country. We also collected data on monofocal (MF) lenses prices from four brands in Portugal (Essilor®, Hoya®, Zeiss® and Shamir®), with different characteristics, directly from brands representatives. We only collected price on polycarbonate or Trivex (PNX) lenses, which are the safest for children, due to their impact resistance.[12] DSL price from Hoya® (MiYOSMART®) and Essilor® (Stellest®) were collected from brand representatives. We only selected DSL with published long-term studies (more than 2 years).

Cost estimates were done for four consecutive years of myopia prevention treatment, with different scenarios according to lens refraction changes and the need to exchange spectacle lens. We considered final prices for lens' change every 6, 12, 16 or 24 months. Eyeglasses frame was not considered.

Whenever there was a price range according to lens refraction, a medium value was used. Time and number of appointments was not taken into account, considering that the need of a frequent follow up was independent of the chosen treatment.

COST CALCULATION:

We calculated compound atropine and DSL treatment cost per year as follows:

- Compound atropine: 4 years of compound atropine median cost + 4 years of monofocal MF lens cost, according to minimum, mean and maximum cost, dividing for four years of treatment;
- DSL: DSL cost, according to DIMS or HAL option, for one year of treatment;

Atropine median, maximum and minimum price was calculated. In the final global analysis, only compound atropine median value was utilized, taking into consideration the substantial range of values observed. Also, patients do not have the genuine opportunity to freely choose the most economically favourable pharmacy, as their options are limited to the pharmacies in close proximity to them.

We performed different analysis of the cost for the mean, maximum and minimum prices obtained between the different MF brands and lens type. We also calculated different costs according to lens changes every 6 months, 12, 16 and 24 months.

RESULTS

BASELINE COSTS:

Compound atropine price was independent of its concentration. Most pharmacies specified a bottle expiration date of 15 days, with the exception of a single pharmacy that extended it to 30 days. Consequently, the cost of atropine was calculated on a monthly basis, considering the expiration date provided by each pharmacy, and then multiplied by 12 months to determine the annual cost of treatment. Median compound atropine price for one year of treatment was 319.92€ (minimum=144.00€; maximum=592.80€). Table 1 shows median, minimum and maximum com-

Table 1. Compound Atropine Median Costs, According to Duration of Treatment.

Cost	Median, €	Minimum, €	Maximum, €
1 month	26.66	12.00	49.40
1 year	319.92	144.00	592.80
4 years	1279.68	576.00	2371.20

Table 2. Monofocal Lens Cost, According to Lens Exchange, for 4 years.

Cost	Mean, €	Minimum, €	Maximum, €
Every 6 months	1157.36	672.00	1952.00
Every 12 months	578.68	336.00	976.00
Every 16 Months	434.01	252.00	732.00
Every 24 Months	318.68	168.00	488.00

pound atropine cost according to duration of treatment.

At the time of submission of this paper, DSL final cost in Portugal for the consumer from Hoya® MiYOSMART® DIMS lenses were 390€ and from Essilor®, Stellest® HAL lenses were 416€.

Mean monofocal polycarbonate or trivex lens price was 144.67€ (minimum=84.00€; maximum=244.00€). According to the need for lens change, different costs for 4 years of treatment are presented on Table 2.

ANNUAL TREATMENT COSTS FOR A DURATION OF 4 YEARS ACROSS VARIOUS SCENARIOS:

Regarding the median values for atropine treatment and the complete range of values of MF lens, DSL treatment showed to be less expensive for lens change every 12 months or less frequently. Atropine treatment was deemed more favourable than DSL in terms of cost only when the need for lens exchange occurred every 6 months or more frequently. Table 3 presents varying price combinations based on lens change intervals of every 6, 12, 18, or 24 months, considering median values for compound atropine cost. Calculations were performed on an annual basis for the duration of four consecutive years of treatment.

DISCUSSION

In order to compare the costs between defocus spectacle lens and low concentration atropine in myopia progression prevention in the Portuguese setting, we made cost estimates for four consecutive years of myopia prevention treatment. We compared the baseline costs of compound atropine drops and MF lens versus DSL alone, within different scenarios according to spectacle lens exchange.

According to our results, compound atropine and MF lens take a cost advantage in prevention of myopia progression, in cases where there was the need of lens exchange every 6 months or more frequently. However, in situations where there was the need of lens exchange within a period of 12 months or less frequently, DSL might be a less expensive solution. Myopia prevention treatment would be expected to increase the durability of lenses, due to a less regular need for change in refraction. Therefore, DSL seems a less expensive option. However, we must take into account that some children are more prone to regularly break their glasses, which could make atropine plus MF lens more economical valuable in some situations. Additionally, atropine treatment involves frequent family visits to the pharmacy, leading to an escalation in the total expenses.

Our results consider the prices at the time of submission, acknowledging that they may vary in the coming

Table 3. Annual Treatment Costs for a Duration of 4 Years of Treatment, According to Lens Exchange Frequency.

Spectacle Lens Change	Atropine Treatment*: Atropine + MF (Min.-Max.), €	DIMS, €	HAL, €
Every 6 Months	609.25 (**487.92** – 807.92)	780.00	832.00
Every 12 Months	464.59 (403.92 – 563.92)	**390.00**	416.00
Every 16 Months	428.42 (382.92 – 502.92)	**292.50**	312.00
Every 24 Months	392.25 (361.92- 441.92)	**195.00**	208.00

The values underlined and in bold reflect the lowest cost for each option.

HAL= highly aspherical lenslets; DIMS= defocused incorporated multiple segments; MF= monofocal; Min.= minimum; Max.= maximum

*Calculated as: median price for compound atropine + mean/minimum/maximum price for MF lenses

months as new DSL lenses enter the market. This dynamic can potentially enhance the affordability of DSL options due to the competitive effects of the market.

LIMITATIONS

One limitation to our study was the fact that we could not determine the exact number of pharmacies in Portugal which produce compound atropine, meaning we cannot know if the sample of pharmacies that we included is statistically sufficient. Also, we did not include pharmacies in more rural areas which could import compound atropine from other pharmacies, with additional costs for transportation. This fact introduces a bias in the calculations of mean costs. We tried to overcome this problem by contacting as many pharmacies as we could and presenting both minimum and maximum prices, as well as the median price. Another limitation was the different costs that lens brands offered for the same kind of lens according to the refraction needed, which we tried to overcome by using mean values.

Also, the analysis of total costs in different scenarios included mainly comparisons among the minimum, median and maximum values of both compound atropine and MF lens. However, the number of possible combinations is infinite. This phenomenon could generate a bias of information concerning the price of different choice possibilities. That is why we present the maximum and minimum prices, which mark out the possible costs.

We have not conducted a comprehensive cost analysis that includes expenses such as doctor's appointments for patient monitoring and the costs of tests and exams. However, it is important to note that this limitation is partially mitigated by the similarity of these factors in both treatment options.

RELEVANCE

When it comes to selecting a treatment for myopia, families consider factors such as cost, accessibility, and children's compliance as crucial determinants. Since there is currently insufficient evidence to make decisions based solely on treatment effectiveness, these factors hold even more significance. In terms of cost, our study found that DSL is favourable, especially for situations where lens replacement occurs every 12 months or longer. This is particularly applicable to children undergoing myopia progression treatment, as the slower progression of axial length necessitates less frequent lens changes.

Considering myopia as a global pandemic with increasing prevalence and incidence worldwide, it is important to realize the economic burden to both patients and general society. According to Lin Chua *et al*. the annual prevalence-based direct costs for myopia ranged from $14-26 (USA), $56 (Iran) and $199 (Singapore) per capita.[13]

Without additional interventions, the economic burden of myopia will escalate in proportion to its growing prevalence. Therefore, it is crucial to conduct further investigations to yield more universally agreed and consistent results on cost data, ensuring a comprehensive and reproducible assessment of myopia treatment expenses on a global scale.

In Portugal, the availability of low concentration atropine drops is limited to compounding in pharmacies, leading to increased prices. In both treatment options, household finances cover the expenses. Conducting more comprehensive and cost-effectiveness studies on the efficacy of low-dose atropine in preventing myopia progression could potentially encourage the Portuguese government to contribute towards reducing the cost of atropine treatment for affected patients. This could ultimately result in a significant shift in costs and alleviate the financial burden associated with myopia treatment.

CONCLUSION

We believe our findings to be of indisputable importance in daily practice, as they may prove insightful to doctors and patients' informed choice regarding myopia prevention treatment.

The investment in myopia prevention treatments in childhood is a benefit to the patient by reducing the personal, functional and financial costs of a future higher myopia. It is imperative for health policies to prioritize the issue of myopia, considering the projected increase in its prevalence and the subsequent impact on future healthcare expenses.

In order to shape and refine health policies, it is crucial to conduct additional studies that not only examine the cost-effectiveness of various treatment options for preventing myopia progression but also investigate the optimal age to discontinue treatment. These studies will help determine the optimal choice of treatment and provide valuable insights for policy revision.

CONTRIBUTORSHIP STATEMENT / DECLARAÇÃO DE CONTRIBUIÇÃO:

All authors contributed to the study conception and design. Material preparation and data collection were performed by SG and PBdS. Data analysis was performed by PBdS. The first draft of the manuscript was written by PBdS, SG, IL and ALB and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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