

Comparison of PyMuPDF + Unstructured Vs Adobe

Analysis & Examples

Feb 13<sup>th</sup>, 2024

## Agenda Slide

- Background and Objective
- Comparison Adobe vs Combination of PyMUPDF and Unstructured
- Application output Comparison
  - Response Comparison
  - Accurate Table Parsing
- Parser output Comparison
  - Paragraph Order and Segmentation Comparison
  - Parser Output Comparison Tables



## Background and Objective

## **Background**

- Application and Use of PDF parser
  - PDF parsers are employed to extract data from PDF files, transforming it into a Text format that can be ingested into a vector database. This data can then be utilized to retrieve pertinent information in response to user queries.
- Challenges
  - The extraction of data from PDFs can pose significant challenges due to the unstructured nature and diverse styles employed in different files.
  - Accurate classification of images, tables, and paragraph continuity, as well as extracting text from scanned PDFs (OCR), can be particularly difficult.

## **Objective**

- The solution lies in utilizing PDF parsers that are trained using machine learning. These parsers are capable of understanding the relative positioning and reading order across columns and page breaks, thereby enhancing the accuracy and efficiency of data extraction.
- We conducted a comparison analysis across multiple PDF parsers and tested them on selected PDFs using various parameters. The current analysis specifically contrasts the performance of Adobe PDF parser and combination of PyMUPDF and Unstructured . The objective is to determine the most suitable PDF parsing approach in alignment with data security policies.



## Comparison Adobe vs Combination of PyMuPDF and Unstructured

Com	hination	of two	packages
COIII	ibiliation	OI LVVO	packages

Parameters	Adobe PDF Parser	PyMUPDF + Unstructured Hi Res	PyMuPDF	Unstructured – Hi Res (Detectron)
Scanned document	Yes	Yes Unstructured – Hi Res	No	Yes
paragraph order	Most Precise — (Numbered, Order Maintained)	Above Average PyMUPDF	Above Average (Not Numbered, Header, footnotes order not maintained, Impacted by Tables, Other Blocks)	Average (Not Numbered, Header, footnotes order not maintained, Impacted by Tables, Images & Other Blocks)
Columns	Able to read complex docs (3 columns)	Able to read but may loose order & content in some places.  PyMUPDF	Able to read complex docs (3 columns) but needs cleaning (example extra \n)	Able to read but may loose order & content in some places.
Tagging	Most Precise (Images, Tables, P, H1, H2, Footnotesetc)	Above Average Tagging (Deployed User defined tagging model for tagging and cleaning leveraging font information)  PyMUPDF	No Explicit Tags (text info eg, font size & name which can utilized for user defined tagging model) - Creates obj for tables	Below Average Tagging (No Image tags, wrong title, header tags)
Tables	Most Precise	Good (Missing content, HTML format) Unstructured – Hi Res	Poor (Missing content, Reading normal text as table, loosing uniformity)	Good (Missing content, HTML format)
Images/ Graphs	<mark>Yes</mark>	Need to explore PyMUPDF	Yes (only RGB & Grayscale images)	Need to explore
Time Complexity	3-6 sec per page (depends on complexity)	Relatively higher than Adobe and individual packages. (Need to explore & utilize parallel processing)	1 sec for 1-2 pages (depends on complexity)	Relatively higher (Need to explore & utilize parallel processing)



# Application output Comparison

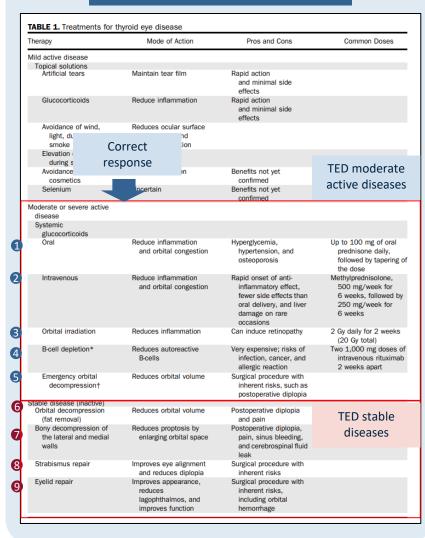
Comparing the Application query response for Adobe and Combination of PyMUPDF and Unstructured



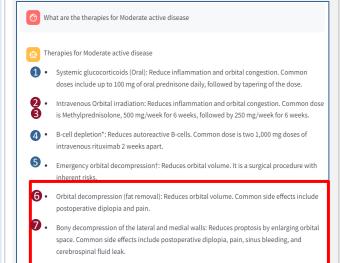
## Response Comparison

### Question: What are the therapies for moderate active diseases

## Original PDF table



## Unstructured + PyMuPDF Parser



Strabismus repair: Improves eye alignment and reduces diplopia. It is a surgical procedure

Eyelid repair: Improves appearance, reduces lagophthalmos, and improves function. It is a

### Insights

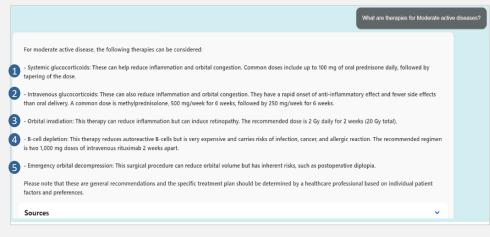
 Wrong Information in response & missed therapy details. (highlighted in red circles)

surgical procedure with inherent risks, including orbital hemorrhage.

- For Moderate active disease, only first 5 points (marked in blue) should come while last 4 therapies are also included in response.
- It shows that parser missed some text & parsed with wrong order for some rows.

### Adobe Parser





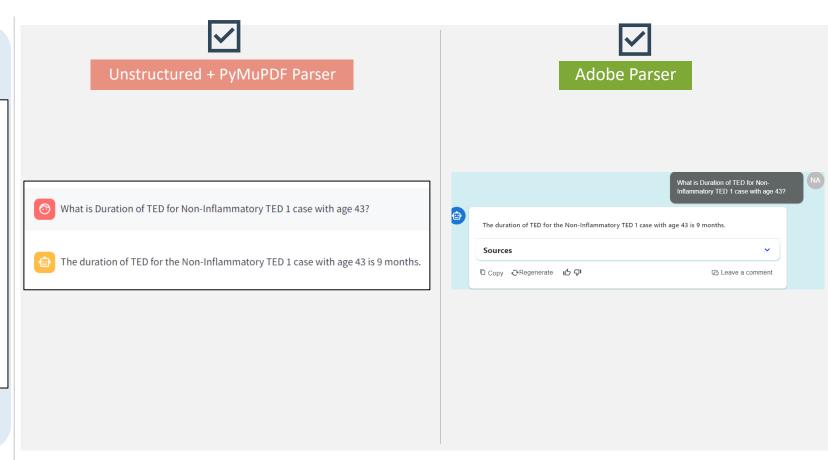
### Insights

Correct Response

## Accurate Table Parsing

## Original PDF table

Case	Gender	Age	Smoker?	Duration of TED (months)	CAS
Non-Inflammatory TED 1	M	43	Yes (20 years)	9	1
Non-Inflammatory TED 2	M	70	No	18	1
Non-Inflammatory TED 3	F	47	No	12	1
Non-Inflammatory TED 4	F	33	No	9	1
Non-Inflammatory TED 5	F	57	No	108	1
Inflammatory TED 1	M	29	Yes (8 years)	6	5
Inflammatory TED 2	M	35	Yes (10 years)	14	4
Inflammatory TED 3	F	50	No	88	3
Inflammatory TED 4	F	49	No	15	3
Inflammatory TED 5	M	53	Yes (30 years)	12	3
Control 1	M	48	No	-	-
Control 2	F	63	No	-	-
Control 3	M	47	No	-	-
Control 4	F	42	No	-	-
Control 5	M	53	No	_	_



# Parser output Comparison

Comparing the parser generated output of Adobe and Combination of PyMUPDF and Unstructured



recent studies until April 1, 2021.\n",

for\ninclusion criteria and then reviewed to catalog the results.\n",

and trial\noutcomes (eg, change from baseline in proptosis).\n",

311.78192138671875,

488.15826416015625,

539.4005126953125.

622.5857543945312.

311.7825927734375.

637.3286743164062.

539.3622436523438.

725.8577270507812

323.7561950683594.

76.07433319091797,

364.9618225097656

85.05453491210938.

323.7561950683594,

515.3381958007812,

91.281982421875,

Unstrucuted + PyMuPDF Parser

**Adobe Parser** 



Proptosis and Diplopia Response in Moderate to Severe Thyroid Eve Disease

hypoid eve disease (TED), or Graves ophthalmopathy. is an autoimmune disorder characterized by progressive inflammation and damage to orbital and ocular tissues.1,2 Age-adjusted prevalence in the US is estimated at 0.25%.3 Thyroid eye disease causes expansion of retroorbital fat and extraocular muscle, thought to be mediated primarily by the upregulation of the insulin like growth factor 1 receptor on orbital fibroblasts. Patients may develop considerable disfiguring facial changes owing to proptosis, disabling diplopia, and in severe cases, vision loss.1

currently there are limited noninvasive treatment options that improve proptosis and diplopia. The Para European Group on Graves' Orbitopathy (EUG lines recommend a cumulative dosage of 4.5 to venous methylprednisolone (IVMP) over 12 weeks for most tients with moderate to severe active TED.4 Although da demonstrate that IVMP is associated with reduced inflamm: tion, the dose, timing of administration, and duration of therapy vary in the literature, making it challenging to compare the clinical results, particularly on the progressive outcomes of proptosis and diplopia. A 2-mm reduction in proptosts and a 1-grade improvement in diplopta have been considere clinically meaningful in prior TED clinical trials.

Food and Drug Administration-approved treatment for TED. 5,6 A literature review was conducted to identify existing pub-Teprotumumab, a fully human, monoclonal antibody, inhibits insulin like growth factor 1 receptor activity and reduces of patients with moderate to severe TED demonstrated that teprotumumab was associated with clinically significant 24 weeks,7,8

to our knowledge, there are currently no studies directly IVMP with teprotumumab or placebo; as such, matchingadjusted indirect comparisons (MAICs) simulating direct comparisons between treatments can be used to estimate | Screening and Selection Criteria comparative treatment effects. The objectives of this study are to (1) to evaluate improvements in proptosis and diplopia vere active TED using MAICs.

### Method

para sources included deidentified patient-level data for tepro tumumab or placebo from the phase 2 (NCT01868997) and 3 (NCT03298867) trials and published aggregate-level data for IVMP (4.5-5 g over 12 weeks). Data for patients receiving teprotumumab or placebo were obtained from 2 published trials; a phase 2 trial that included 43 patients and 45 patients in the teprotumumab and placebo groups, respectively, and a phase 3 trial that included 41 patients and 42 patients in the teprotumumab and placebo groups. 7,8 Given the similar

Original Investigation Research

### stion Is teprotumumab more efficacious than intravenou methylprednisolone (IVMP) for proptosis and diplopia?

dings. This meta-analysis and matching-adjusted indirect mnarison showed an association with small improvements i ptosis from baseline for IVMP vs placebo (-0.16 mm); eater with teprotumumab vs IVMP (treatment difference -2.31 mm). For diplopia response, IVMP was not favored over placebo while teprotumumab was favored over IVMP.

ning Improvements in proptosis and diplopia with IVMP vs placebo may be small/not clinically relevant; in this meta-analysis eprotumumab was associated with greater improvements in ptosis and diplopia vs IVMP, but clinical trials are needed to onfirm the clinical relevance of this finding.

inclusion and exclusion criteria, data were pooled to obtain treatment arms with 84 randomized patients and 87 randomized patients for teprotumumab and placebo.

lished literature assessing the most commonly recommended dose of IVMP among patients with moderate to severe active downstream pathogenic signaling in TED. A total of 2 placebo- TED. PubMed and Embase were searched for relevant RCTs controlled, double-masked, randomized clinical trials (RCTs) and observational studies from database inception to date of search (October 5, 2020) using a search strategy that included key terms and controlled vocabulary (eg, "intravereductions in inflammation, proptosis, and diplopia over | nous steroid," "Graves' orbitopathy," "thyroid eye disease," "Graves' ophthalmopathy") (search strategy presented in eAppendix 1 in the Supplement). Results were filtered to include only studies conducted in humans. Regular alerts were established to capture any recent studies until April 1, 2021.

study inclusion was based on PICOS (population, intervention, comparator, outcomes, and study design) criteria estabwith the most recommended treatment regimen of IVMP as | lished a priori. Briefly, only studies including patients with reported in the literature and (2) to compare these results | moderate to severe active TED receiving treatment with IVMP teprotumumab and placebo in patients with moderate at a dosage of 4.5 g to 5 g over 12 weeks and reporting at least 1 of the 2 outcomes of interest (ie, change from baseline in pro ptosis in millimeters and/or Bahn-Gorman diplopia score) were included.10 Two reviewers (R.A.O. and R.B.) independently reviewed each title and abstract to identify eligible studies. Full texts of eligible studies were also examined for inclusion criteria and then reviewed to catalog the results.

Data were extracted by a single reviewer (R.A.Q.) and verified for accuracy by a second reviewer (R.B.). Data extraction was completed using a standardized form and included study characteristics (eg. authors, study design), eligibility criteria (ie, inclusion and exclusion criteria), patient baseline characeristics (eg, sample sizes, sex, age, smoking status), and trial utcomes (eg, change from baseline in proptosis).

> PDF Adobe Acrobat



 Tables and images, similar to key points, are typically placed at the end of the page, potentially disrupting the following sequence.

```
RCTs\nand observational studies from database inception to date of\nsearch (October 5, 2020) using a search strategy that
in-\ncluded key terms and controlled vocabulary (eg, \u201cintrave-\nnous steroid,\u201d \u201cGraves\u2019 orbitopathy,\u201d
\u201cthyroid eye disease,\u201d\n\u201cGraves\u2019 ophthalmopathy\u201d) (search strategy presented in\neAppendix 1 in the
Supplement). Results were filtered to in-\nclude only studies conducted in humans. Regular alerts were\nestablished to capture any
 "Screening and Selection Criteria∖nStudy inclusion was based on PICOS (population, interven-\ntion, comparator, outcomes, and study
design) criteria estab-\nlished a priori. Briefly, only studies including patients with\nmoderate to severe active TED receiving
treatment with IVMP\nat a dosage of 4.5 g to 5 g over 12 weeks and reporting at least\n1 of the 2 outcomes of interest (ie, change
from baseline in pro-\nptosis in millimeters and/or Bahn-Gorman diplopia score)\nwere included.10 Two reviewers (R.A.Q. and R.B.)
indepen-\ndently reviewed each title and abstract to identify eligible\nstudies. Full texts of eligible studies were also examined
"Data Extraction\nData were extracted by a single reviewer (R.A.Q.) and verified\nfor accuracy by a second reviewer (R.B.). Data
extraction was\ncompleted using a standardized form and included study\ncharacteristics (eg, authors, study design), eligibility
criteria\n(ie, inclusion and exclusion criteria), patient baseline charac-\nteristics (eg, sample sizes, sex, age, smoking status)
 "Ouestion Is teprotumumab more efficacious than intravenous\nmethylprednisolone (IVMP) for proptosis and diplopia?\n",
```

```
> P[7]: Currently there are limited noninvasive treatment opti...
     Path: "//Document/P[7]"
> P[8]: On January 21, 2020, teprotumumab became the first US ...
     Path: "//Document/P[8]'
> P[9]: To our knowledge, there are currently no studies direc...
     Path: "//Document/P[9]"
> H1: Methods
     Path: "//Document/H1"
   2: Patients Receiving Teprotumumab and Placebo
 P[10]: Data sources included deidentified patient-level data...
     Bounds: [323.76, 706.48, 367.20, 718.19]
     HasClip: false
     Text: "Key Points "
  > attributes:
> P[2]: Question Is teprotumumab more efficacious than intrave...
     Path: "//Document/Aside[2]/P[2]"
> P[3]: Findings This meta-analysis and matching-adjusted indi...
     Path: "//Document/Aside[2]/P[3]"
  P[4]: Meaning Improvements in proptosis and diplopia with IV...
P[11]: inclusion and exclusion criteria, data were pooled to...
     Path: "//Document/P[11]'
> H2[2]: Literature Review for IVMP
     Path: "//Document/H2[2]'
> P[12]: A literature review was conducted to identify existin...
     Path: "//Document/P[12]"
> H2[3]: Screening and Selection Criteria
     Path: "//Document/H2[3]"
> P[13]: Study inclusion was based on PICOS (population, inter...
     Path: "//Document/P[13]"
```

### **Insights**

- Ensure that the sequence of para, such as para 10 followed by para 11, is maintained without any disruption.
- Key points is tagged differently hence help to identify right sequence.

## Parser Output Comparison – Tables

## Original PDF table

E / Cumman	of recommendations	on ucado of tone	otumumah for thuro	d ove disease

TABLE 4. Summary of	recommendations on usage of teprotumumab for thyroid eye disease
	Recommendations
Treatment population	Age: adults; use with in caution in postpubertal adolescents  Nyroid status: any, can be started concomitantly with attempts to achieve euthyroidism  ED status: progressive disease
	TED severity: clinically significant Previous treatment of thyroid/TED: any
Contraindications	Poorly controlled diabetics, pregnant or planning to become pregnant, nursing mothers, and
	prepubertal children
	Those on concomitant biologics, or those who received rituximab within 6 months
	Patients with inflammatory bowel disease should be treated with caution and comanaged with gastroenterologists
Dose and duration	1st infusion: 10 mg/kg (over 90 minutes)
	2nd infusion: 20 mg/kg (over 90 minutes)
	Subsequent infusions: 20 mg/kg (over 60 minutes)
	Total of 8 infusions (every 3 weeks)
	Early discontinuation if no improvement at 4–6th infusion
	Additional doses if severe disease with continued improvement
Pre-infusion screen	Complete medical (including weight and BP measurement) and ophthalmic examination
	Baseline laboratory results: fasting blood glucose, HgA1c, LFTs, and CBC Baseline EKG

BP, blood pressure; CBC, complete blood count; EKG, electrocardiography; HgA1c, hemoglobin A1c; LFTs, liver function tests; TED, thyroid eye disease.

In patients with diabetes: fasting blood glucose after each of the 1st 2 infusions. Selfmonitoring at least twice a day. Work in conjunction with endocrinologist.

Drug monitoring

## Unstructured + PyMuPDF Parser

Recommendations



Adobe Parser



Treatment population	Age: adults; use with in caution in postpubertal adolescents hyroid status: any, can be started concomitantly with attempts to achieve euthyroidism ED status: progressive disease ED severity: clinically significant
	hose on concomitant biologics, or those who received rituximab within 6 months
	Patients with inflammatory bowel disease should be treated with caution and comanaged with gastroenterologists
Dose and duration	st infusion: 10 mg/kg (over 90 minutes) 2nd infusion: 20 mg/kg (over 90 minutes) Subsequent infusions: 20 mg/kg (over 60 minutes) otal of 8 infusions (every 3 weeks) Early discontinuation if no improvement at 4-6th infusion
	Additional doses if severe disease with continued improvement
Pre-infusion screen	Complete medical (including weight and BP measurement) and ophthalmic examination  Baseline laboratory results: fasting blood glucose, HoAlc LETs, and CRC Baseline EKG

In patients with diabetes: fasting blood glucose after each of the 1st 2 infusions. Selfmonitoring at least twice a day. Work in conjunction with endocrinologist.

	Recommendations
Treatment population	Age: adults; use with in caution in postpubertal adolescents
	Thyroid status: any, can be started concomitantly with attempts to achieve euthyroidism
	TED status: progressive disease
	TED severity: clinically significant
	Previous treatment of thyroid/TED: any
Contraindications	Poorly controlled diabetics, pregnant or planning to become pregnant, nursing mothers, and prepubertal children
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	Total of 8 infusions (every 3 weeks)
	Early discontinuation if no improvement at 4–6th infusion
	Additional doses if severe disease with continued improvement
Pre-infusion screen	Complete medical (including weight and BP measurement) and ophthalmic examination
	Baseline laboratory results: fasting blood glucose, HgA1c, LFTs, and CBC
	Baseline EKG
Drug monitoring	In patients with diabetes: fasting blood glucose after each of the 1st 2 infusions. Self-monitoring at least twice a day. Work in conjunction with endocrinologist.

## Insights

Drug

monitoring

Inaccurate table data Reading

- Missed few rows (marked in red box in Original PDF Table)
- 2. Some words are incomplete (highlighted in yellow in the above table).

## Insights

- Accurate table structure identification.
- Returns parsed output in csv format.

## Parser Output Comparison – Tables

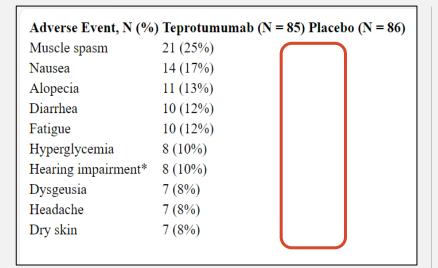
## Original PDF table

**TABLE 3.** Adverse events from combined Phase 2 and Phase 3 trials

Adverse Event, N (%)	Teprotumumab (N = 85)	Placebo (N = 86)
Muscle spasm	21 (25%)	6 (7%)
Nausea	14 (17%)	8 (9%)
Alopecia	11 (13%)	7 (8%)
Diarrhea	10 (12%)	7 (8%)
Fatigue	10 (12%)	6 (7%)
Hyperglycemia	8 (10%)	1 (1%)
Hearing impairment*	8 (10%)	0
Dysgeusia	7 (8%)	0
Headache	7 (8%)	6 (7%)
Dry skin	7 (8%)	0

<sup>\*</sup>Hearing impairment includes deafness, Eustachian tube dysfunction, hyperacusis, hypoacusis, and autophony.

## Unstructured + PyMuPDF Parser



## Insights

- 1. Inaccurate table data identification.
- 2. Missed column values (marked in red box)

## Adobe Parser

Adverse Event, N (%)	Teprotumumab (N = 85)	Placebo (N = 86)
Muscle spasm	21 (25%)	6 (7%)
Nausea	14 (17%)	8 (9%)
Alopecia	11 (13%)	7 (8%)
Diarrhea	10 (12%)	7 (8%)
Fatigue	10 (12%)	6 (7%)
Hyperglycemia	8 (10%)	1 (1%)
Hearing impairment*	8 (10%)	0
Dysgeusia	7 (8%)	0
Headache	7 (8%)	6 (7%)
Dry skin	7 (8%)	0

## Insights

- L. Accurate table data identification.
- 2. Returns parsed output in csv format.



## Original PDF table

Therapy	Mode of Action	Pros and Cons	Common Doses
Mild active disease			
Topical solutions			
Artificial tears	Maintain tear film	Rapid action and minimal side effects	
Glucocorticoids	Reduce inflammation	Rapid action and minimal side effects	
Avoidance of wind, light, dust, and smoke	Reduces ocular surface desiccation and reduces irritation		
Elevation of head during sleep	Reduces orbital congestion		
Avoidance of eye	Reduces irritation	Benefits not yet	
cosmetics		confirmed	
Selenium	Uncertain	Benefits not yet	
		conimica	
Moderate or severe active disease			
Systemic glucocorticoids			
Oral	Reduce inflammation	Hyperglycemia,	Up to 100 mg of oral
	and orbital congestion	hypertension, and osteoporosis	prednisone daily, followed by tapering of the dose
Intravenous	Reduce inflammation and orbital congestion	Rapid onset of anti- inflammatory effect, fewer side effects than oral delivery, and liver damage on rare occasions	Methylprednisolone, 500 mg/week for 6 weeks, followed by 250 mg/week for 6 weeks
Orbital irradiation	Reduces inflammation	Can induce retinopathy	2 Gy daily for 2 weeks (20 Gy total)
B-cell depletion*	Reduces autoreactive B-cells	Very expensive; risks of infection, cancer, and allergic reaction	Two 1,000 mg doses of intravenous rituximated weeks apart
Emergency orbital decompression†	Reduces orbital volume	Surgical procedure with inherent risks, such as postoperative diplopia	
Stable disease (inactive) Orbital decompression (fat removal)	Reduces orbital volume	Postoperative diplopia and pain	
Bony decompression of the lateral and medial walls	Reduces proptosis by enlarging orbital space	Postoperative diplopia, pain, sinus bleeding, and cerebrospinal fluid leak	
Strabismus repair	Improves eye alignment and reduces diplopia	Surgical procedure with inherent risks	
Eyelid repair	Improves appearance, reduces lagophthalmos, and improves function	Surgical procedure with inherent risks, including orbital hemorrhage	

## Insights

Inaccurate table data reading & structure identification -

- Combined 2 rows information in one. (highlighted in yellow).
- 2. Wrong order of text.

## Unstructured + PyMuPDF Parser

Therapy	Mode of Action	Pros and Cons	Common Doses
Mild active disease			
Topical solutions Artificial tears	Maintain tear film	Rapid action and minimal side	
Glucocorticoids	Reduce inflammation	effects Rapid action and minimal side	
Avoidance of wind, light, dust, and	Reduces ocular surface desiccation and	effects	
smoke Elevation of head	reduces irritation Reduces orbital		
during sleep Avoidance of eye	congestion Reduces irritation	Benefits not yet	
cosmetics Selenium	Uncertain	confirmed Benefits not yet	
Moderate or severe active confi	rmed		
disease Systemic			
glucocorticoids Oral	Reduce inflammation and orbital congestion	Hyperglycemia, hypertension, and osteoporosis	Up to 100 mg of oral prednisone daily, followed by tapering of the dose
Intravenous Orbital irradiation	Reduce inflammation and orbital congestion Reduces inflammation	Rapid onset of anti- inflammatory effect, fewer side effects than oral delivery, and liver damage on rare occasions Can induce	Methylprednisolone, 500 mg/week for 6 weeks, followed by 250 mg/week for 6 weeks 2 for 2 weeks
B-cell depletion*	Reduces autoreactive	retinopathy Very expensive; risks of	Gy daily (20 Gy total) Two 1,000 doses of
Emergency orbital	B-cells Reduces orbital volume	infection, cancer, and allergic reaction Surgical procedure with	mg intravenous rituximab 2 weeks apart
decompressiont Stable disease (inactive)		inherent risks, such as postoperative diplopia	
Orbital decompression (fat removal)	Reduces orbital volume	Postoperative diplopia and pain	
Bony decompression of the lateral and medial walls	Reduces proptosis by enlarging orbital space	Postoperative diplopia, pain, sinus bleeding, and cerebrospinal fluid leal	
Strabismus repair	Improves eye alignment and reduces diplopia	Surgical procedure with inherent risks	
Eyelid repair Reproduced with permission from	Improves appearance, reduces lagophthalmos, and improves function (2)	Surgical procedure with inherent risks, including orbital hemorrhage	

## Adobe Parser





Therapy	Mode of Action	Pros and Cons	Common Doses
Mild active disease			
Topical solutions			
Artificial tears	Maintain tear film	Rapid action and minimal side effects	
Glucocorticoids	Reduce inflammation	Rapid action and minimal side effects	
Avoidance of wind, light, dust, and smoke	Reduces ocular surface desiccation and reduces irritation		
Elevation of head during sleep	Reduces orbital congestion		
Avoidance of eye cosmetics	Reduces irritation	Benefits not yet confirmed	
Selenium	Uncertain	Benefits not yet confirmed	
Moderate or severe active disease			
Systemic glucocorticoids			
Oral	Reduce inflammation and orbital congestion	Hyperglycemia, hypertension, and osteoporosis	Up to 100 mg of oral prednisone daily followed by tapering of the dose
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Strabismus repair	Improves eye alignment and reduces diplopia	Surgical procedure with inherent risks	
Eyelid repair	Improves appearance, reduces lagophthalmos, and	Surgical procedure with inherent risks,	
	improves function	including orbital hemorrhage	























PHILADELPHIA







